Issued May 1971

SOIL SURVEY

Bennett County, South Dakota

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
and
UNITED STATES DEPARTMENT OF THE INTERIOR
Bureau of Indian Affairs
In cooperation with
SOUTH DAKOTA AGRICULTURAL EXPERIMENT STATION

Major fieldwork for this soil survey was done in the period 1958–62. Soil names and descriptions were approved in 1965. Unless otherwise indicated, statements in this publication refer to conditions in the county in 1965. This survey was made cooperatively by the Soil Conservation Service and by the Bureau of Indian Affairs and the South Dakota Agricultural Experiment Station. This survey is part of the technical assistance furnished to the Oglala Sioux Tribe and to the Bennett County Conservation District. Either enlarged or reduced copies of the soil map in this publication can be made by commercial photographers, or they can be purchased on individual order from the Cartographic Division, Soil Conservation Service, USDA, Washington, D.C. 20250.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms, ranches, and woodlands; in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability of tracts of land for farming industry, and recreation.

Locating Soils

All the soils of Bennett County, South Dakota, are shown on the detailed map at the back of this survey. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbols. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" can be used to find information. This guide lists all the soils of the county in alphabetic order by map symbol and gives the range site classification, the capability classification, and the windbreak classification of each. It also gives the page where each soil and each classification is described.

Individual colored maps showing the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and the information in the text. Translucent material can be used as an overlay on the soil map and can be colored to show soils that have the same degree of limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and ranchers and those who work with them can learn about use and management of the soils from the soil descriptions and from the discussions of the range sites, capability units, and windbreak suitability groups.

Range users and others can find, under "Use of the Soils as Range," groupings of the soils according to their suitability for range and the names of most of the plants that grow on each range site.

Foresters and others can refer to the section "Use of the Soils for Windbreaks" where the soils of the county are grouped according to their suitability for trees and shrubs.

Game managers, sportsmen, and others can find information about soils in relationship to common birds and animals in the section "Managing Soils for Wildlife."

Engineers and builders can find, under "Engineering Uses of Soils," tables that contain test data, estimates of soil properties, and information about soil features that affect engineering properties.

Scientists and others can read about how the soils formed and how they are classified in the section "Formation and Classification of the Soils."

Newcomers to Bennett County may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They also may be interested in the information about the county given in the section "General Nature of the County."

Cover picture: Silty range site in excellent condition. This is one of the most productive upland range sites in Bennett County.

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Issued May 1971

SOIL SURVEY OF BENNETT COUNTY, SOUTH DAKOTA

BY EARL CHAMBERLIN AND ROBERT E. RADEKE, SOIL CONSERVATION SERVICE

SOILS SURVEYED BY WARREN F. JOHNSON, IN CHARGE, AND EARL CHAMBERLIN, SOIL CONSERVATION SERVICE, AND EDWARD BOOKLESS, RICHARD KRUGER, ROY LEMBKE, JACK STAFFORD, AND ALBERT THURMAN, BUREAU OF INDIAN AFFAIRS[1]

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, AND UNITED STATES DEPARTMENT OF INTERIOR, BUREAU OF INDIAN AFFAIRS, IN COOPERATION WITH THE SOUTH DAKOTA AGRICULTURAL EXPERIMENT STATION

BENNETT COUNTY is in the southwestern part of South Dakota (fig. 1). It extents 44½ miles from east to west and about 27 miles from north to south. The total area of the county is 760,960 acres. Martin, the county seat, is the largest town. Smaller towns and villages are Allen, Harrington, Patricia, Swett, Tuthill, and Vetal.

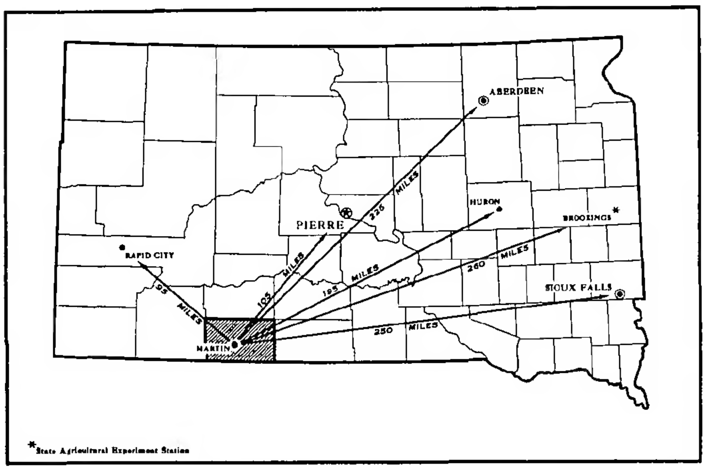

Figure 1.—Location of Bennett County in South Dakota.

About 9,423 acres is owned by the Federal government. About 9,362 acres of this is the LaCreek Migratory Waterfowl Refuge, including 4,779 acres of inland waters and marsh. The Bureau of Indian Affairs administers, in trust, about 300,000 acres. Most of the land owned by Indians is in the northern part of the county, but throughout the county, scattered tracts are intermingled with patented lands owned by non-Indians.

Bennett County is on the northernmost high plain in the Great Plains physiographic province. An extension of the Nebraska sandhills, where relief is rolling, crosses the southern part of the county. The central part of the county is a gently sloping tableland. Relief in the northern part is rolling to hilly. The Little White River drains the southern part of Bennett County, and the northern part is drained and deeply dissected by intermittent streams that flow northward into the White River.

Wheat farming and livestock ranching are the main agricultural enterprises. Only about 23 percent of the county is cropland. Winter wheat and alfalfa are the main crops. Also grown are barley, oats, rye, corn, and sorghums. In and near the sandhills, subirrigated meadows are a dependable source of wild hay.

How This Survey Was Made

This survey was made to learn what kinds of soils are in Bennett County, where they are located, and how they can be used. Soil scientists went into the county knowing they likely would find many soils they had already seen and perhaps some they had not. As they traveled over the county, they observed the steepness, length, and shape of slopes, the size and speed of streams, the kinds of native plants or crops, the kinds of rock, and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by the action of plant roots.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The categories of their classification most used in a local survey are the *soil series* and the *soil phase.*

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are

[1] Others who contributed to the soil survey are R. J. LARSEN and T. B. WILLIAMS, Soil Conservation Service, United States Department of Agriculture, and REX L. CAREY and JOHN FOREMAN, Bureau of Indian Affairs, United States Department of the Interior.

similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Dunday and Anselmo, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface soil and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Dunday loamy fine sand, 0 to 6 percent slopes, is one of several phases within the Dunday series.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map in the back of this publication was prepared from the aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series, or of different phases within one series. Two such kinds of mapping units are shown on the soil map of Bennett County: soil complexes and undifferentiated groups.

A soil complex consists of areas of two or more soils, so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. The name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Dunday-Anselmo complex, 3 to 9 percent slopes, is an example.

An undifferentiated group is made up of two or more soils that could be delineated individually but are shown as one unit because, for the purpose of the soil survey, there is little value in separating them. The pattern and proportion of soils are not uniform. An area shown on the map may be made up of only one of the dominant soils, or of two or more. The name of an undifferentiated group consists of the names of the dominant soils, joined by "and." Tuthill and Anselmo fine sandy loams, 5 to 9 percent slopes, is an example.

In most areas surveyed there are places where the soil material is so rocky, so shallow, or so severely eroded that it cannot be classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Blown-out land is a land type in Bennett County.

While a soil survey is in progress, soil scientists take soil samples needed for laboratory measurements and for engineering tests. Laboratory data from the same kinds of soils in other places are also assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soils. Yields under defined management are estimated for all the soils.

The soil scientists set up trial groups of soils on the basis of yield and practice tables and other data they have collected. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others. Then they adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in Bennett County. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern and proportion.

A map showing soil associations is useful to people who want a general idea of the soils in a county, who want to compare different parts of a county, or who want to know the location of large tracts that are suitable for a certain kind of land use. Such a map also is a useful general guide in managing a watershed, a wooded tract, or a wildlife area, or in planning engineering works, recreational facilities, and community development. It is not a suitable map for planning the management of a farm or field or for selecting the exact location of a road, building, or similar structure, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The six soil associations in Bennett County are described in the following pages. For most of the associations, the bearing capacity of the soils is said to be "poor," "fair," or "good." These ratings should not be given a specific value in pounds per square foot.

1. Valentine Association

Rolling to hilly, excessively drained, deep, sandy soils on uplands

This association, an extension of the Nebraska sandhills, reaches across the south side of the county. It consists of rolling, small, rounded hills and ridges ranging from 20 to 75 feet high. Distinct surface drainageways are lacking, but scattered throughout the association are dry valleys, subirrigated basins, spring-fed marshes, and sandhill lakes.

This association covers a total area of about 190,300 acres, or about 25 percent of the county. About 80 percent of it is made up of Valentine soils, and 20 percent of other soils.

Valentine soils are loose sands having a thin surface layer that is slightly darkened by organic matter.

Other soils are the Dunday, Elsmere, Gannett, and Loup. The Dunday soils occupy dry valleys. The Elsmere and Loup soils occupy subirrigated basins and valleys and have a fluctuating water table at a shallow to moderate depth. Gannett soils have a water table that is at or close to the surface during most of the growing season. They occupy low areas that are adjacent to sandhill marshes and lakes.

Small acreages of the Anselmo, Canyon, Oglala, Rosebud, and Tassel soils also are in this association. Anselmo soils are mostly on the north side of the association in the eastern part of the county. The Canyon, Oglala, Rosebud, and Tassel soils occur in scattered areas where the soils are shallow or moderately deep over the underlying sandstone. Figure 2 shows the pattern of soils in this and adjacent associations.

Almost all of this association is in native grass that is grazed. The meadows on Elsmere, Gannett, and Loup soils are a dependable source of hay. Water of good quality is available for livestock from wells, springs, dugouts, and sandhill lakes. The wells and springs also provide water for domestic use. Less than 1 percent of the association is cropland, and alfalfa is the main crop. Because these sandy soils blow easily, maintaining a good cover of grass is essential in preventing blowouts.

Cattle ranching is the main enterprise in this association. Ranches average about 5,000 acres in size, but some are as large as 35,000 acres. A State highway and a main county road cross the association from north to south. Most areas are accessible by ranch trails, but some hilly areas are accessible only on horseback.

The soils in this association are too sandy for constructing terraces and farm ponds. Septic tank and tile sewage disposal systems are suitable, but in places they may contaminate ground water. Highway construction and maintenance are affected by exposed soil surfaces because the soils blow easily. These soils have good bearing capacity if confined and serve well for building foundations and road fill.

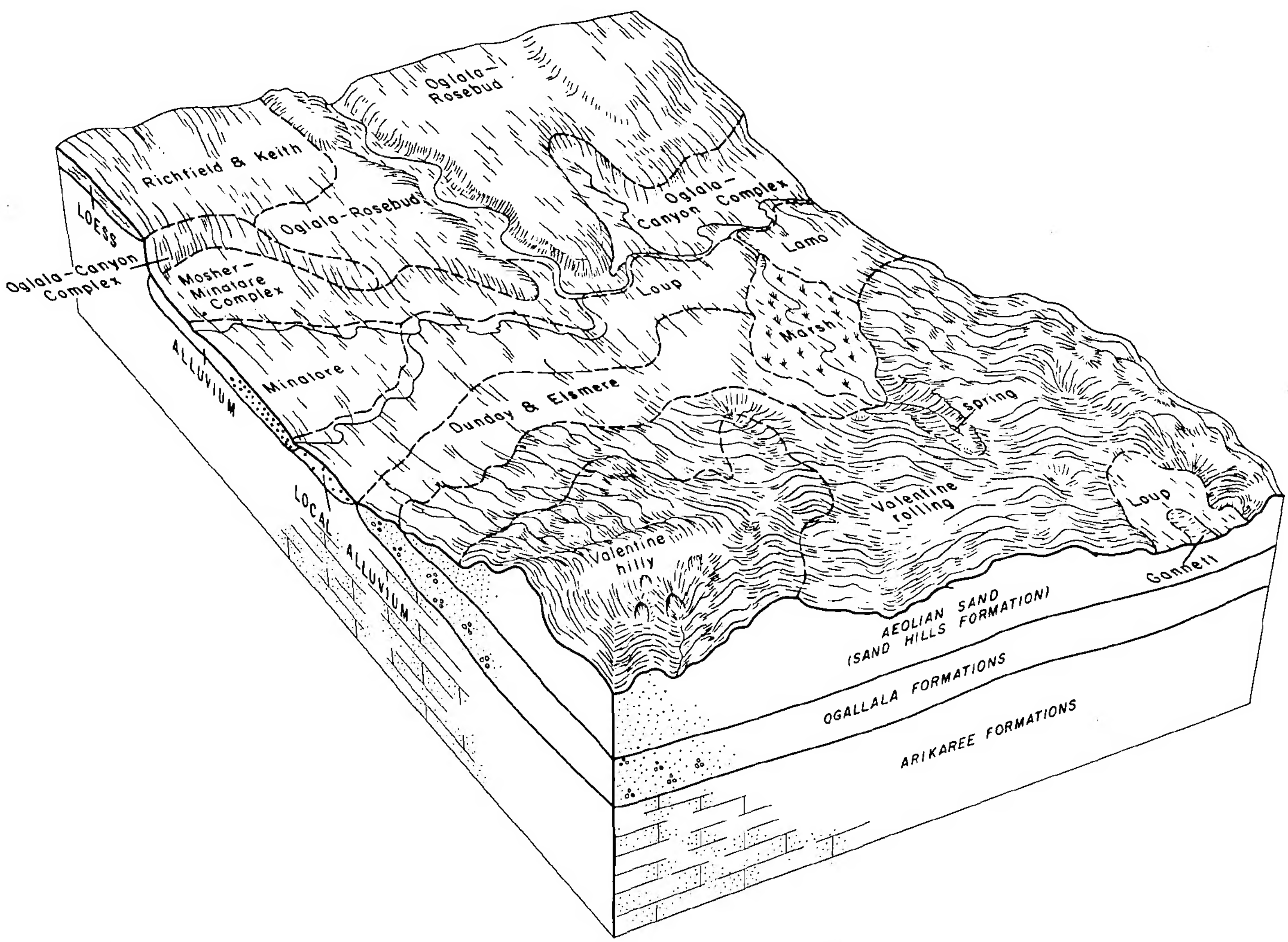

Figure 2.—**Typical association of Valentine, Mosher, Minatare, Loup, Keith, Rosebud, Oglala, and Canyon soils in the southern part of Bennett County.**

2. Anselmo Association

Gently sloping to hilly, well-drained to excessively drained, deep, loamy and sandy soils on uplands

This association of loamy and sandy soils is on uplands in the eastern part of the county. East of the village of Vetal and south of U.S. Highway No. 18, the soils are gently sloping to undulating. North of that highway, the soils are rolling to hilly.

This association covers a total area of about 103,000 acres, or 14 percent of the county. About 25 percent is made up of Anselmo soils, 15 percent each of Dunday, Tuthill, Valentine, and Tassel soils, and 15 percent of less extensive minor soils.

Anselmo soils are deep, dark-colored fine sandy loams. They are scattered throughout the association and are closely intermingled with other extensive soils in the association.

Dunday soils are dark-colored loamy fine sands that occupy the more undulating areas. Tuthill soils have a dark-colored fine sandy loam surface layer similar to that of the Anselmo soils, but below the surface layer the Tuthill soils are more clayey and have stronger structure than the Anselmo soils. Tuthill soils are gently sloping and occupy the longer, smoother slopes in the association. The light-colored Valentine soils are undulating to rolling sands that occupy ridges and knolls south of U.S. Highway No. 18. North of that highway, Valentine soils occur as scattered pockets of windblown sand and are closely intermingled with Tassel soils in hilly areas. Tassel soils are light-colored, calcareous fine sandy loams that are shallow to soft, calcareous sandstone. They are rolling to hilly and occur east and north of Vetal.

Minor soils that occur mainly in this association are in the Holt and Vetal series. The Holt soils are similar to Tuthill soils but are moderately deep to deep over soft, calcareous sandstone. They are mainly in the northeastern part of the county near the village of Patricia. Vetal soils have a thicker dark-colored surface layer than the Anselmo soils. Vetal soils occupy round-bottomed swales of the uplands and long, concave slopes. They are below the Tassel and Valentine soils, which occupy the steeper slopes of the ridges.

Scattered remnants of high tablelands are above the hilly soils along the east county line and are capped with silty loess. On these remnants and in other areas where islands of silty and loamy materials occur, there are small tracts of Canyon, Colby, Dawes, Goshen, Hoven, Keith, Oglala, Richfield, Rosebud, and Ulysses soils.

Most of this association is in native grass and is used for grazing and hay. About 10 percent of the association is cultivated. Alfalfa, spring-sown grains, and corn are the main crops. Some winter wheat is grown on the Tuthill soils and on scattered tracts of the Keith soils. In some areas of this association near Harrington and Vetal, soil blowing was considerable in the 1930's, when the cultivated acreage was larger. Many of the formerly cultivated areas are now in native grass or have been seeded to tame grasses.

A few livestock farms are in this association, but cattle ranching is the main enterprise. Ranches are as much as 15,000 acres in size, but the average size is about 2,200 acres. Graded roads are along some section lines on the more gently sloping soils. Most areas of hilly soils are accessible by ranch trails.

In most of this association, the underlying materials are too porous to hold water well enough for the soils to be sites for farm ponds or sewage lagoons. Wells and springs supply water for livestock and for domestic use. Many of the soils have only slight limitations to use for septic tanks and tile sewage systems, but ground water could be contaminated in some areas. Terraces and diversions can be constructed on Tuthill soils, but on most of the soils in this association, these structures are poorly suited because the underlying materials are rapidly permeable and the soils are erodible. Most of the soils in the association have good stability and bearing capacity for earth structures, highway subgrades, and foundations for buildings.

3. Keith-Rosebud Association

Nearly level to gently sloping, well-drained, deep, silty soils and moderately deep, loamy soils on uplands

This association consists of nearly level to gently sloping soils on tablelands in two areas. The larger area is north of the Little White River. The smaller area is in the south-central part of the county, south of the Little White River. Many of the soils in this association formed in a thin mantle of silty loess.

This association covers a total area of about 162,000 acres, or about 21 percent of the county. About 45 percent is made up of Keith soils, 30 percent of Rosebud soils, 10 percent of Richfield soils, and 15 percent of minor soils.

Keith soils are deep and have a dark-colored silt loam surface layer and a firm to friable silty clay loam and silt loam subsoil. They are nearly level in tablelike areas and are gently sloping on long, smooth slopes that face east and south in many places.

Rosebud soils typically have a dark-colored loam surface layer and a friable heavy loam subsoil. Fine fragments of sandstone are in the lower part of the subsoil, and the soils are moderately deep to bedded, fine-grained sandstone that is soft and calcareous. Rosebud soils occupy the shorter slopes in this association.

Richfield soils are nearly level and commonly occur on the tablelands southeast of Martin. These soils contain more clay and have stronger structure in the subsoil than Keith soils.

Minor soils in this association are in the Canyon, Colby, Dawes, Goshen, Hoven, Oglala, and Ulysses series. The Canyon soils are on the ridgetops and knolls and appear distinctly white in cultivated fields. Colby and Ulysses soils are on rounded ridges and knolls and occur closely with Keith soils. Dawes and Goshen soils are on foot slopes and in upland swales. Hoven soils occupy upland depressions. The Oglala soils mostly are gently sloping soils on long slopes south of the village of Swett. Figure 3 shows a typical pattern of soils in the Keith-Rosebud association.

About 85 percent of this association is cultivated and is the main crop-producing area in the county. Winter

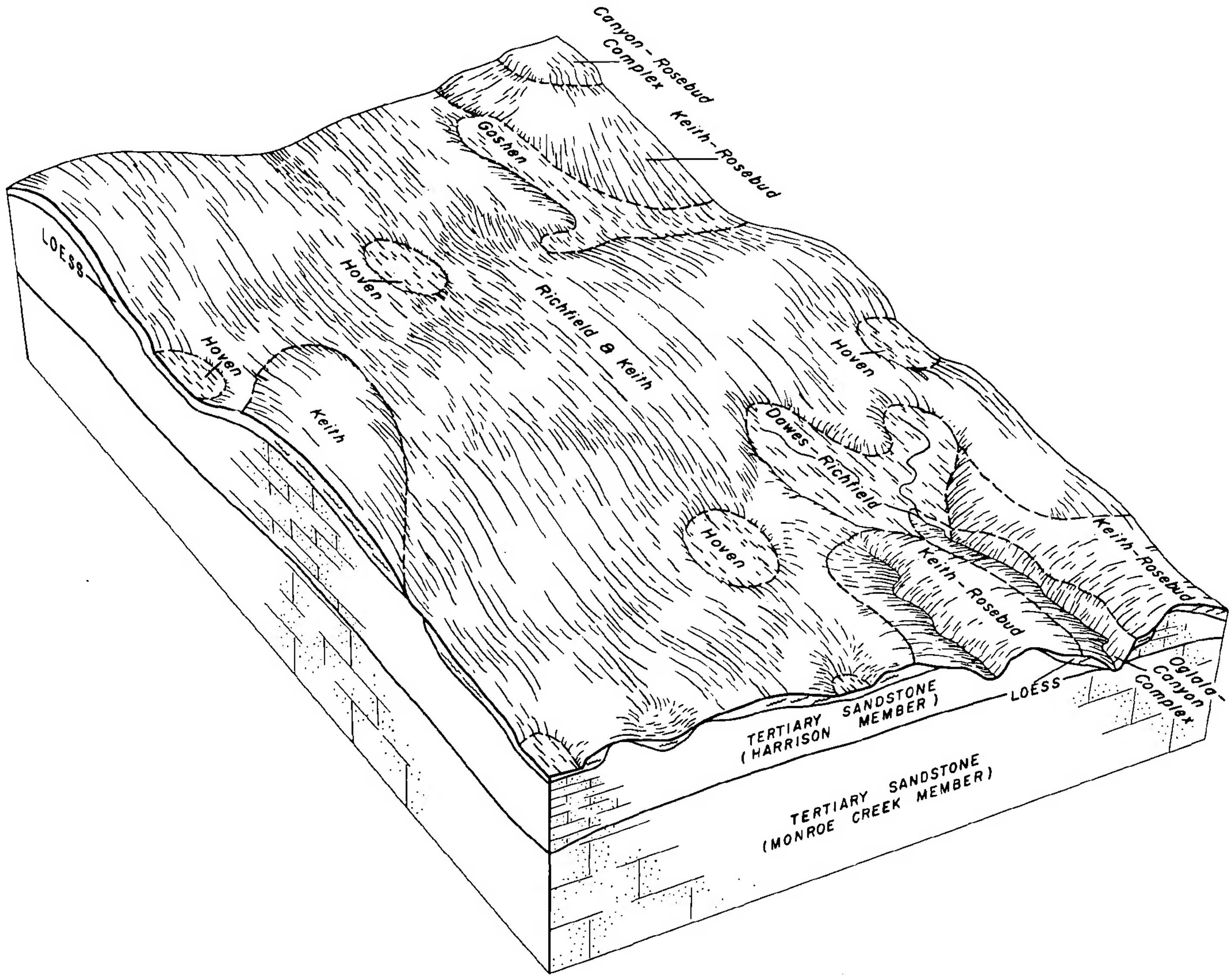

***Figure 3.*—Typical pattern of soils in the Keith-Rosebud association.**

wheat is the main crop, and oats, barley, corn, and alfalfa are also grown. Some of the farmers raise beef cattle. A few raise dairy cattle, hogs, and chickens. Farms average about 800 acres in size, but they range from 160 acres to as much as 5,000 acres. Roads and trails are on section lines, and the association is well crossed by highways and county roads.

Level terraces and grassed waterways generally are satisfactory means for controlling erosion on the cropland in this association. Terraces, however, are not suited in fields that have numerous areas of Canyon soils. Because many of the soils have permeable underlying material, compacted seal blankets and the use of sealing agents are necessary in places so as to enable ponds and sewage lagoons to hold water. Wells provide water for domestic and livestock use in most areas. Highways are subject to frost heave. The major soils in this association have fair to poor bearing capacity.

4. Oglala-Canyon Association

Rolling to hilly, well-drained and somewhat excessively drained, loamy soils that are deep to shallow over soft sandstone; on uplands

This association is in the northern part of the county. Rolling soils are dominant, but gently sloping soils occur as small isolated tabletops or where drainage divides have broadened and flattened. The association is dissected by deeply entrenched tributaries flowing northward to the White River, which forms the northern boundary of adjacent Washabaugh County. Most of the hilly areas are on the steep sides of rough, broken valleys and canyons.

This association covers a total area of about 214,380 acres, or about 28 percent of the county. About 35 percent is made up of Oglala soils, 35 percent of Canyon soils, 15 percent of Colby, Keith, and Ulysses soils, and 15 percent of less extensive minor soils.

Oglala soils have a dark-colored loam surface layer. Below this layer is light-colored, friable loam that contains about the same amount of clay as the surface layer. Lime is leached to a depth below 25 inches, and soft, calcareous sandstone typically is at a depth of 42 inches. Oglala soils occur on the mid and lower slopes of the association.

Canyon soils are light-colored, calcareous loams that are shallow to soft, calcareous, bedded sandstone, which contains thin, hard layers. These soils are on ridgetops and steep slopes of the valleys and canyons.

Scattered throughout the association in areas of rolling ridges are patches of silty Colby, Keith, and Ulysses soils. These soils generally occur on south- and east-facing slopes.

Other minor soils in this association are in the Dawes, Goshen, Richfield, and Rosebud series. The Dawes and Richfield soils occupy flat areas in association with the nearly level Keith soils on ridgetops. Goshen soils are on foot slopes and upland swales. The Rosebud soils are on some of the wider ridges of the association or are on side slopes in bands between Canyon and Oglala soils. Soils in mixed alluvium are on narrow flood plains along intermittent streams. The upper part of figure 2 shows the position of Oglala and Canyon soils in respect to Rosebud, Keith, and Richfield soils.

Most of this association is in native grass and is used for grazing and hay, and about 10 percent is in cultivated crops. Some winter wheat is grown on the more gently sloping soils, but much of the cropland is used for feed grains and alfalfa that provide winter feed for livestock. Ranches average about 3,000 acres in size, and raising of beef cattle is the main enterprise. Several good roads cross the association, but most of it is accessible only by winding ranch trails.

Level terraces and grassed waterways help to control erosion in scattered areas of cropland. The permeable materials underlying the soils of this association impair the water-holding capabilities of farm ponds and sewage lagoons, but the wells and the springs in most areas provide water for livestock and for domestic use. The rolling to hilly soils are of limited use for sewage disposal systems and roads. Measures to control roadside erosion are essential. Highways are subject to frost heave. The major soils in this association have fair to poor bearing capacity.

5. Kadoka-Epping Association

Gently sloping to hilly, well-drained to excessively drained, silty soils that are moderately deep to shallow over silt and bedded siltstone; on uplands

In this county this association occurs along intermittent streams that have cut their way down into the underlying siltstone. Four widely separated small tracts are along the northern county line, adjoining extensive areas of this association in Washabaugh County.

This association covers a total area of about 3,000 acres, or less than 1 percent of the county. About 45 percent is made up of Kadoka soils, 35 percent of Epping soils, and 20 percent of minor soils.

The Kadoka soils are gently sloping and well drained. They typically have a dark-colored silt loam surface layer and a firm silty clay loam subsoil. Pink siltstone is at a depth of about 30 inches.

Epping soils are gently sloping to hilly and somewhat excessively drained to excessively drained. They are light-colored, calcareous silt loams that are shallow to siltstone. Spots of siltstone crop out in areas of Epping soils.

Also in this association are areas of the Colby, Dawes, Goshen, Keith, and Richfield soils.

Most of this association is in native grass that is used for grazing and hay. A few small tracts of Kadoka, Keith, and Richfield soils are in cultivated crops, mainly winter wheat and alfalfa.

On the soils in this association farm ponds hold water satisfactorily in most places. Topography unfavorably affects highway construction, and measures to control roadside erosion are needed. Highways are subject to frost heave. The main soils are unstable and have poor bearing capacity.

6. Mosher-Minatare-Loup Association

Nearly level, somewhat poorly drained and poorly drained, deep, loamy soils and soils with a claypan; on stream valleys, terraces, and basins

This association consists of soils on bottom lands, terraces, and upland valleys and basins. In places these soils have a fluctuating water table. The association is mainly along the Little White River and Stinking Water and Lake Creeks. Another area is south and east of the village of Patricia.

This association covers a total area of about 87,000 acres, or about 12 percent of the county. About 25 percent is made up of Mosher soils; 20 percent of Minatare soils; 20 percent of Loup soils; 10 percent of Lamo soils; 10 percent of closely intermingled Dawes and Keith soils; 10 percent of Marsh interspersed with bodies of water; and 5 percent of many less extensive minor soils.

Mosher soils are deep, dark colored, and somewhat poorly drained. They have a silt loam surface layer, about 8 inches thick, that is underlain by a claypan. Salts are visible at depths below 12 inches, and a water table fluctuates between depths of 3 and 7 feet. Mosher soils are dominant in the Patricia area and on upland valleys and terraces near the village of Tuthill.

In the western part of the county, along Stinking Water Creek, the Minatare and Loup soils are dominant in this association. The poorly drained Loup soils are dark colored and loamy. Their water table is at the surface for short periods in spring and seldom falls below a depth of 40 inches in summer. These soils occupy lower areas along the creek channel and on the southern side of the creek. Minatare soils have a thin surface layer and a claypan. They are strongly alkaline because the salts rise into the upper part of the soils when the water table moves upward. The nearly level Minatare soils are on flats that are 1 to 5 feet above the Loup soils and are mainly on the north side of the valley. The central part of figure 2 shows the relationship and position of these soils in a stream valley.

Lamo soils have a dark-gray silt loam surface layer and a water table that is near the surface early in the growing season and seldom falls below a depth of 4 feet

in summer. These soils occur throughout the association. Dawes and Keith soils are closely intermingled and occur on terraces to the east and south of Tuthill.

Of lesser extent in this association are the Anselmo, Bankard, Dunday, Elsmere, and Haverson soils, Alluvial land, and Marsh. Anselmo soils are on undulating benches near Tuthill. Dunday and Elsmere soils are scattered throughout the association. Alluvial land and areas of Bankard and Haverson soils are along the Little White River. Large areas of Marsh occur along Lake Creek and in the LaCreek Migratory Waterfowl Refuge south of Tuthill.

Most of this association is used for grazing and hay crops. Less than 10 percent of it is cultivated. Most of the cropland is on Anselmo, Dawes, Keith, and Mosher soils. Winter wheat and alfalfa are the main crops. Small areas of Anselmo, Dawes, and Keith soils near Tuthill are irrigated by sprinkler systems. Forage plants grow well on the subirrigated meadows. Much of the acreage of this association serves as a winter feed base for ranches on or near the association. About 10 percent of the association is a Federal wildlife refuge for migratory waterfowl. Several good roads cross this association.

Because large areas of this association have a water table near the surface or within a depth of 7 feet, sewage disposal systems are not practical. This water table, however, favors good growth of plants for hay or grazing, and complete drainage systems generally are not needed. Dug ponds and shallow wells provide water for livestock.

Descriptions of the Soils

In this section the soils of Bennett County are described in detail. The approximate acreage and proportionate extent of each mapping unit are shown in table 1. Their location is shown on the soil map at the back of this survey.

The procedure in this section is first to describe a soil series, and then the mapping units in that series. Thus, to get full information on any one mapping unit, it is necessary to read both the description of that unit and the description of the soil series to which the unit belongs. The description of the soil series mentions features that apply to all the mapping units in the series. Differences among the soils of a series are pointed out in the descrip-

TABLE 1. —*Approximate acreage and proportionate extent of the soils*

Soils	Acres	Percent
Alluvial land	13, 720	1. 8
Altvan loam, 0 to 5 percent slopes	1, 680	. 2
Anselmo fine sandy loam, 0 to 5 percent slopes	3, 432	. 5
Anselmo-Tassel complex, 9 to 18 percent slopes	12, 086	1. 6
Bankard loamy fine sand	1, 510	. 2
Blown-out land	1, 408	. 2
Canyon complex, 18 to 40 percent slopes	45, 274	6. 0
Canyon-Oglala complex, 18 to 40 percent slopes	53, 782	7. 1
Canyon-Rock outcrop complex	5, 217	. 7
Canyon-Rosebud complex, 3 to 12 percent slopes, eroded	5, 457	. 7
Dawes-Keith complex, 0 to 3 percent slopes	9, 883	1. 3
Dawes-Richfield silt loams, 0 to 5 percent slopes	8, 860	1. 2
Dunday loamy fine sand, 0 to 6 percent slopes	2, 654	. 3
Dunday-Anselmo complex, 0 to 3 percent slopes	2, 558	. 3
Dunday-Anselmo complex, 3 to 9 percent slopes	20, 034	2. 6
Dunday and Elsmere loamy fine sands	13, 911	1. 8
Dunday-Valentine complex, 0 to 5 percent slopes	6, 327	. 8
Epping complex, 9 to 40 percent slopes	782	. 1
Gannett fine sandy loam	6, 000	. 8
Goshen silt loam, 0 to 3 percent slopes	11, 461	1. 5
Goshen silt loam, 3 to 6 percent slopes	607	. 1
Gravelly land	441	. 1
Haverson loam, 0 to 3 percent slopes	1, 203	. 2
Holt and Tuthill fine sandy loams, 0 to 5 percent slopes	2, 410	. 3
Holt and Tuthill fine sandy loams, 5 to 9 percent slopes	4, 960	. 7
Hoven silt loam	4, 418	. 6
Kadoka silt loam, 3 to 5 percent slopes	635	. 1
Keith silt loam, 0 to 3 percent slopes	6, 220	. 8
Keith silt loam, 3 to 5 percent slopes	9, 846	1. 3
Keith-Colby silt loams, 9 to 12 percent slopes	3, 370	0. 4
Keith-Rosebud silt loams, 0 to 2 percent slopes	11, 656	1. 5
Keith-Rosebud silt loams, 2 to 6 percent slopes	78, 464	10. 3
Keith and Ulysses silt loams, 5 to 9 percent slopes	4, 005	. 5
Lamo silt loam	6, 022	. 8
Loup fine sandy loam	9, 314	1. 2
Marsh	9, 843	1. 3
Minatare soils	8, 163	1. 1
Mosher-Minatare complex	18, 833	2. 5
Oglala-Canyon complex, 9 to 18 percent slopes	86, 910	11. 4
Oglala-Rosebud silt loams, 0 to 3 percent slopes	1, 813	. 2
Oglala-Rosebud silt loams, 3 to 6 percent slopes	1, 812	. 2
Richfield and Keith silt loams, 0 to 2 percent slopes	15, 812	2. 1
Richfield and Keith silt loams, 2 to 6 percent slopes	16, 764	2. 2
Tassel-Anselmo complex, 18 to 40 percent slopes	5, 467	. 7
Tuthill and Anselmo fine sandy loams, 0 to 5 percent slopes	13, 448	1. 8
Tuthill and Anselmo fine sandy loams, 5 to 9 percent slopes	9, 019	1. 2
Valentine fine sand, rolling	148, 468	19. 5
Valentine fine sand, hilly	26, 124	3. 4
Valentine-Tassel complex, hilly	12, 931	1. 7
Vetal and Goshen soils, 0 to 3 percent slopes	4, 497	. 6
Vetal-Holt fine sandy loams, 6 to 15 percent slopes	5, 440	. 7
Water in areas less than 40 acres in size	1, 081	. 1
Inland water and marsh in areas more than 40 acres in size	4, 928	. 7
Total	760, 960	100. 0

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tion of the unit discussed or are indicated by the soil name.

A profile typical for each series is described in two ways. Many will prefer to read the short descriptions in narrative form. It is the second paragraph in the description of each said series. The technical description of the profile is mainly for soil scientists, engineers, and others who need to make thorough and precise studies of the soils. Unless otherwise stated, the profile described is that of a dry soil.

As explained in the section "How this Survey Was Made," not all mapping units are members of a soil series. Alluvial land and Blown-out land, for example, are land types that do not belong to any soil series. They are listed, nevertheless, in alphabetic order along with the soil series.

Following the name of each mapping unit, there is a symbol in parentheses. This symbol identifies the mapping unit on the soil map. Listed at the end of a mapping unit are the range site, capability unit, and windbreak suitability group in which the mapping unit has been placed. The "Guide to Mapping Units" at the back of this survey lists the pages where each of these groups and the mapping units are described. Many terms used in the soil descriptions are defined in the Glossary and in the "Soil Survey Manual" (*19*).[2]

Alluvial Land

Alluvial land (0 to 2 percent slopes) (Aa) is on narrow bottom lands in nearly all parts of the county except the sandhills. Meandering channels break these bottom lands into small parcels. In most parts of Bennett County, the water table in this land type is within the reach of grass roots. The soil material ranges from loamy sand to silt loam in texture, is light colored to dark colored, and is generally calcareous. In some places Alluvial land is similar to the Elsmere, Lamo, or Loup soils.

Included with this land type in mapping, in the east-central part of the county, are small areas of Bankard soils. Also included, in the northern part, are small areas of Haverson soils.

Most of this land is in native grasses and varying amounts of trees and shrubs. A few small tracts are in cultivated crops, mainly alfalfa. This land type also is used for family garden plots.

Flooding, which damages fences and deposits sediments and trash, is the main hazard. Also, the water table rises close to the surface during the growing season in most places. Use of this land for grazing, hay, and wildlife lessens the risk of flood damage. (Subirrigated range site; capability unit VIw-1; windbreak suitability group 3)

Altvan Series

The Altvan series consists of nearly level to gently sloping, loamy soils that are moderately deep over gravel. These soils formed in loamy alluvium underlain by gravelly materials. They occur on terraces in the northeastern part of the county.

In a typical profile the surface layer, about 10 inches thick, is dark-gray loam. The subsoil is about 17 inches thick. The upper part is dark grayish-brown clay loam that is hard when dry and firm when moist. The lower part is grayish-brown sandy clay loam that is hard when dry and friable when moist. The underlying material is light-gray gravelly sandy loam in the upper part and light brownish-gray gravelly loamy sand below.

Altvan soils are well drained. Surface runoff is slow to medium. Permeability is moderate through the subsoil but is moderately rapid to rapid in the underlying material. Although these soils have moderate water-holding capacity, they are somewhat droughty because of the gravelly underlying material. These soils have moderate natural fertility and are easy to work.

The native vegetation on Altvan soils consists of mid and short grasses. About 50 percent of the small acreage in Bennett County is cultivated. Winter wheat, oats, barley, alfalfa, and tame grasses are the main crops.

Typical profile of Altvan loam, 0 to 5 percent slopes, in a cultivated field, 2,240 feet west and 75 feet north of the southeast corner, section 8, T. 39 N., R. 33 W.:

Ap—0 to 5 inches, dark-gray (10YR 4/1) loam, very dark gray (10YR 3/1) when moist; weak, fine, granular structure; soft, friable; mildly alkaline; abrupt, smooth boundary.

A12—5 to 10 inches, dark-gray (10YR 4/1) loam, very dark gray (10YR 3/1) when moist; very weak, coarse, prismatic structure breaking to weak, medium, subangular blocky structure; soft, friable; mildly alkaline; abrupt, smooth boundary.

B2t—10 to 21 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, prismatic structure breaking to moderate and strong, medium, subangular blocky structure; hard, firm; thin, continuous clay films; mildly alkaline; clear, wavy boundary.

B3t—21 to 27 inches, grayish-brown (10YR 5/2) sandy clay loam, dark grayish brown (10YR 4/2) when moist; weak, coarse, prismatic structure breaking to weak, medium, subangular blocky structure; hard, friable; thin, patchy clay films; mildly alkaline; clear boundary.

C1—27 to 32 inches, light-gray (10YR 7/2) gravelly sandy loam, light brownish gray (10YR 6/2) when moist; massive; soft, very friable; mildly alkaline; abrupt boundary.

IIC2—32 to 50 inches, light brownish-gray (10YR 6/2) gravelly loamy sand, grayish-brown (10YR 5/2) when moist; single grain; loose; calcareous; moderately alkaline.

The A horizon ranges from 5 to 11 inches in thickness and from dark gray to dark grayish brown in color. The B horizon ranges from 10 to 18 inches in thickness and from silty clay loam to sandy clay loam in texture. A few rounded and angular pebbles are scattered throughout the profile in most places. Depth to gravel or to gravel mixed with loamy to sandy materials ranges from 20 to 40 inches.

Altvan soils contain less sand in the surface layer and subsoil than Tuthill soils and have underlying materials that are more gravelly. They are less silty than Keith soils and have gravel and sand at a depth of less than 40 inches.

Altvan loam, 0 to 5 percent slopes (AlB).—This soil occupies stream terraces and benches in the northeastern part of the county. It occurs in areas of more than 30 acres in size. In most areas slopes are less than 3 percent, but some gently sloping areas on terrace fronts have short slopes that are as much as 5 percent. On sloping areas the soil has a thinner surface layer and subsoil than described as typical.

Included with this soil in mapping are small, narrow areas of Goshen soils along upland drains. These included soils make up less than 5 percent of the mapping unit.

[2] Italic numbers in parentheses refer to Literature Cited, page 77.

Most of this soil is cropland. Winter wheat and alfalfa are the main crops, and oats, barley, corn, and tame grasses also are grown.

This soil is somewhat droughty because gravel and gravelly materials are at a depth of less than 40 inches. Management is needed that conserves moisture and maintains fertility and tilth. Also needed is management that controls water erosion on the gently sloping terrace fronts. Soil blowing is a secondary concern. (Silty range site; capability unit IIIs-2; windbreak suitability group 2)

Anselmo Series

This series consists of deep, nearly level to rolling soils. These soils occur on uplands, mainly in the eastern part of the county. They formed in weathered sandy materials and contain enough silt to be slightly coherent.

In a typical profile the surface layer is dark-gray fine sandy loam about 8 inches thick. Just below is a transitional layer about 20 inches thick. It is grayish-brown, soft and very friable fine sandy loam to a depth of about 15 inches and grayish-brown loamy fine sand below. The underlying material is light-gray fine sand in the upper part and pale-brown fine sandy loam below. Below a depth of 52 inches, these soil materials are more clayey than the soil materials in the layers above.

Anselmo soils are well drained. Surface runoff is slow, permeability is moderately rapid, and water-holding capacity is moderately low. These soils have moderate natural fertility but are highly susceptible to soil blowing if they are not protected by growing plants or by crop residues.

The native vegetation on Anselmo soils is a mixture of tall, mid, and short grasses. Many areas have remained in native grasses and are used for grazing and hay, but scattered areas are cultivated. The main crops are spring-sown small grains, corn, sorghums, and alfalfa. Some formerly cultivated areas are seeded to tame grasses.

Typical profile of Anselmo fine sandy loam, 0 to 5 percent slopes, 2,000 feet south and 2,440 feet east of the northwest corner, section 28, T. 37 N., R. 33 E.:

A1—0 to 8 inches, dark-gray (10YR 4/1) fine sandy loam, very dark brown (10YR 2/2) when moist; weak, fine, granular structure; soft, very friable; neutral; clear, wavy boundary.

AC1—8 to 15 inches, grayish-brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic structure; soft, very friable; neutral; gradual, wavy boundary.

AC2—15 to 28 inches, grayish-brown (10YR 5/2) loamy fine sand, dark grayish brown (10YR 4/2) when moist; weak, coarse, prismatic structure; soft, very friable; neutral; gradual, wavy boundary.

C1—28 to 52 inches, light-gray (10YR 7/2) fine sand, grayish brown (10YR 5/2) when moist; single grain; loose; neutral; abrupt, smooth boundary.

IIC2—52 to 60 inches, pale-brown (10YR 6/3) fine sandy loam, yellowish brown (10YR 5/4) when moist; single grain; slightly hard, friable; few, prominent, iron stains; neutral.

The A horizon ranges from 4 to 13 inches in thickness and from dark gray to dark grayish brown in color. In eroded cultivated fields, the A horizon is loamy fine sand in places. The AC horizon ranges from 12 to 32 inches in thickness and from dark gray to brown in color. Fine sandy loam or sandy loam is the dominant texture above the C horizon, but in places the lower part of the AC2 horizon is loamy fine sand or loamy sand. Typically the light-colored C horizon is fine sand and loamy fine sand that is free of lime, but in places it is as coarse as sand. Below 40 inches, it may change abruptly to silty or loamy materials. In some places the silty or loamy materials are calcareous.

Anselmo soils are less clayey and of weaker structure below the surface layer than are the Holt or Tuthill soils, which have a B2t horizon. The Anselmo soils contain more silt and are more coherent than Dunday soils. The A1 horizon in Anselmo soils is not so thick as that in Vetal soils.

Anselmo fine sandy loam, 0 to 5 percent slopes (AnB).—This soil occupies gently undulating uplands and nearly level stream terraces in the east-central and northeastern parts of the county. Most areas are more than 40 acres in size.

This soil has the profile described as typical for the series. The underlying sand and loamy materials contain some gravel in places. Where this soil is gently undulating, the surface layer is about 5 inches thick.

Included with this soil in mapping are small areas of Dawes, Goshen, and Vetal soils in narrow upland swales. These included soils make up less than 10 percent of the mapping unit.

About half of the acreage of this soil is cultivated. Spring-sown small grains, corn, alfalfa, and tame grasses are suitable crops. Some winter wheat also is grown, but intensive management is needed to avoid damage from soil blowing.

The main management practices needed are those that control soil blowing and conserve moisture. Practices that maintain fertility and the content of organic matter help to control soil blowing and conserve moisture, and they preserve soil structure as well. (Sandy range site; capability unit IIIe-2; windbreak suitability group 1)

Anselmo-Tassel complex, 9 to 18 percent slopes (AtE).—This complex is on rolling uplands in the eastern and northeastern parts of the county. Areas are more than 40 acres in size. Anselmo soils make up 30 to 50 percent of the mapping unit; Tassel soils, 20 to 40 percent; and other soils, as much as 30 percent. The Anselmo soils occupy the mid and lower slopes (fig. 4), and Tassel soils, the ridges and the upper and generally steeper slopes. The profile of each kind of soil is similar to the one described as typical for its respective series.

Included in some mapped areas of this complex are small tracts of Dunday, Holt, Valentine, and Vetal soils. Dunday and Vetal soils are on some foot slopes and gently sloping swales. Holt soils are on the wider ridgetops and, in some places, are on side slopes. Valentine soils are on some leeward slopes where wind has deposited sand.

All areas of this complex are in native grasses and are used for grazing. In most places the Anselmo soils have slopes that are too erodible for cultivation or are in a pattern with Tassel soils that makes cultivation impractical. Control of soil blowing and water erosion are the main concerns of management on these soils. Proper range use helps control erosion. (Anselmo soils are in the Sandy range site, capability unit VIe-1, and windbreak suitability group 1; Tassel soils are in the Shallow range site and capability group VIs-2, but a windbreak suitability group is not assigned)

Figure 4.—Anselmo-Tassel complex, 9 to 18 percent slopes. Anselmo soils are on mid and lower slopes, and Tassel soils are on the ridges.

Bankard Series

The Bankard series consists of deep, nearly level, loose, sandy soils that occupy bottom lands and low terraces throughout the county. These soils formed in sandy alluvium.

In a typical profile the surface layer is about 9 inches thick. It is light brownish-gray loamy fine sand in the upper part and grayish-brown fine sandy loam in the lower part. Just below is a transitional layer about 8 inches thick. This layer is light brownish-gray loamy fine sand that is loose when dry and very friable when moist. The underlying material is stratified light-gray and light brownish-gray loamy fine sand and fine sand. In this material calcareous layers alternate with noncalcareous layers.

The Bankard soils are somewhat excessively drained. Runoff is slow and permeability is rapid. These soils are porous and have low water-holding capacity. Ground water is at a depth of 8 to 20 feet and is below the reach of grass roots. Bankard soils are low in organic-matter content and natural fertility. Because most areas are so high about the stream channels, these soils are seldom flooded. Where Bankard soils are cultivated, they are highly susceptible to soil blowing.

On these soils the native vegetation is mainly tall and mid grasses. In places native trees grow in scattered clumbs along streams. Most areas of these soils are in native grasses and are used for grazing. Some areas south of Martin are in alfalfa.

Typical profile of Bankard loamy fine sand that formerly was cropland and now is in native grasses, 1,840 feet south and 300 feet east of the northwest corner, section 3, T. 37 N., R. 35 W.:

Ap—0 to 4 inches, light brownish-gray (10YR 6/2) loamy fine sand, grayish-brown (10YR 5/2) when moist; weak, fine, granular structure; loose, very friable; neutral; abrupt, smooth boundary.

A12—4 to 9 inches, grayish-brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; very weak, coarse, prismatic structure; soft, very friable; mildly alkaline; clear, smooth boundary.

AC—9 to 17 inches, light brownish-gray (10YR 6/2) loamy fine sand, dark grayish brown (10YR 4/2) when moist; very weak, coarse, prismatic structure; loose, very friable; mildly alkaline; clear, smooth boundary.

C1—17 to 33 inches, light-gray (10YR 7/2) loamy fine sand, grayish brown (10YR 5/2) when moist; single grain; loose; mildly alkaline; abrupt, smooth boundary.

C2—33 to 45 inches, light-gray (10YR 7/2) loamy fine sand, grayish brown (10YR 5/2) when moist; single grain; loose; calcareous; moderately alkaline; clear boundary.

C3—45 to 55 inches, light-gray (10YR 7/2) fine sand, grayish brown (10YR 5/2) when moist; single grain; loose; moderately alkaline; gradual boundary.

C4—55 to 60 inches, light brownish-gray (10YR 6/2) loamy fine sand, grayish brown (10YR 5/2) when moist; single grain; loose; calcareous; moderately alkaline.

The A horizon ranges from 4 to 12 inches in thickness and from loamy fine sand to fine sandy loam in texture. The AC horizon ranges from 8 to 26 inches in thickness and in places is single grain. The light-colored C horizon is dominantly loamy fine sand and generally is stratified with thin layers of coarse sand and fine sandy loam.

Bankard soils are more sandy and less silty than Haverson soils. They are lighter colored than the Dunday soils and are calcareous at various depths.

Bankard loamy fine sand (0 to 3 percent slopes) (Bk).—This soil occurs mainly along the Little White River. It occupies narrow bottom lands and low terraces, generally in areas of less than 20 acres in size.

East of Tuthill the profile of this soil is that described as typical for the series, but west of Tuthill the soil is fine sandy loam and is somewhat darker.

Included with this soil in mapping, on small, well-drained terraces, are areas of Anselmo fine sandy loam, generally of less than 5 acres in size. Also included are small, narrow strips of mixed alluvium that are similar to Alluvial land. These inclusions make up less than 10 percent of the mapping unit.

Most of this soil is in native grasses that are grazed and used for hay. Alfalfa is the main crop in cultivated areas. Growth of this crop is poor to good, depending on whether the water table is within reach of the alfalfa roots.

Although this soil takes in water readily, it is low in water-holding capacity. It also is low in fertility and is highly susceptible to soil blowing. Management that adds organic matter to this sandy soil helps to control soil blowing and to conserve moisture. (Sands range site; capability unit VIe–2; windbreak suitability group 1)

Blown-Out Land

Blown-out land (3 to 21 percent slopes) (Bo) consists of active sand dunes and blowouts. On this land erosion has removed the surface layer that was slightly darkened by organic matter. The finer sand particles have been blown from this land and deposited on adjacent areas. This blowing has left behind scooped out depressions, dunes, and hummocks of medium sand. This land occurs mainly in the Valentine and Anselmo soil associations in the southern and eastern parts of the county. Areas are from 3 to 40 acres in size.

Blowouts normally start around watering facilities for livestock, near salt areas, and along ranch roads and livestock trails. The main goals of management are to arrest the spread of the blowouts and to revegetate the areas. Measures for dune stabilization are used to accomplish these goals. After vegetation is restored, soil management can be the same as that used on the Valentine soils. (Sands range site; capability unit VIe–2; windbreak suitability group 6)

Canyon Series

This series consists of shallow, loamy soils that are calcareous. These soils occur on uplands and are gently sloping to hilly. They developed in materials weathered from fine-grained limy sandstone on the tops of ridges and knolls and the steep side slopes of buttes, valleys, and V-shaped canyons.

In a typical profile the surface layer, about 4 inches thick, is grayish-brown, calcareous loam. Below the surface layer is a transitional layer about 4 inches thick. It is light brownish-gray, calcareous loam that contains fragments of sandstone and is soft when dry and friable when moist. The underlying material is light-gray, fine-grained, bedded sandstone. It is cemented with lime in the upper part but is softer as depth increases.

The Canyon soils are somewhat excessively drained. Surface runoff is medium to rapid, and permeability is moderately rapid above the sandstone. The natural fertility and water-holding capacity are low. These soils are susceptible to both water erosion and soil blowing where the plant cover is disturbed.

The native vegetation on Canyon soils consists of mid and short grasses. Thin stands of ponderosa pine grow on some of the steeper slopes, but most areas of these soils are in native grass and are used for grazing. Small spots of Canyon soils are cultivated where they occur within larger areas of Keith and Rosebud soils. Crops grow poorly in these spots.

Typical profile of a Canyon loam in native grass, 1,840 feet east and 100 feet north of the southwest corner, section 16, T. 37 N., R. 37 W.:

A1—0 to 4 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft, very friable; calcareous; mildly alkaline; clear, smooth boundary.

AC—4 to 8 inches, light brownish-gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) when moist; weak, fine and medium, granular structure; soft, friable; common angular fragments of sandstone as much as 3 inches in diameter; calcareous; mildly alkaline; abrupt, irregular boundary.

C1—8 to 18 inches, light-gray (10YR 7/2), moderately cemented, fine-grained, bedded sandstone, grayish brown (10YR 5/2) when moist; calcareous; moderately alkaline; abrupt boundary.

C2—18 to 30 inches, light-gray (10YR 7/2), soft, fine-grained, bedded sandstone, grayish brown (10YR 5/2) when moist; calcareous; mildly alkaline.

The A1 horizon ranges from 2 to 5 inches in thickness and from light brownish gray to dark grayish brown in color. Texture is loam, very fine sandy loam, and silt loam. In places the surface layer is noncalcareous. The AC horizon ranges from 3 to 8 inches in thickness and in places has weak subangular blocky structure. In places a calcareous loam to gravelly loam horizon is present. It is as much as 12 inches thick and is the same color as the bedrock. Bedded sandstone is at a depth ranging from 6 to 24 inches and is weakly to strongly cemented. In many places fragments of sandstone are on the surface and make up as much as 25 percent of the subsurface layer, by volume.

The Canyon soils are lighter colored and more shallow to bedrock than Rosebud soils, which have a B horizon. Canyon soils are less silty than Epping soils and are not so sandy as Tassel soils.

Canyon complex, 18 to 40 percent slopes (CnF).—This hilly complex occurs as deeply dissected, V-shaped canyons in the northern part of the county. The topography is rough and broken (fig. 5). The areas are irregularly shaped and in most places are more than 200 acres in size. Canyon soils make up 50 to 70 percent of this complex; other soils, 10 to 40 percent; and Rock outcrop, 10 to 25 percent.

The Canyon soils have a profile like that described as typical for the series. They are steep and occur on side slopes. In most places these soils occur closely with outcrops of partly consolidated fine sandstone.

In most places Goshen, Oglala, and Rosebud soils also are in this complex. The Oglala soils are on the lower parts of slopes that, in some places, are slightly concave. Rosebud soils occur on some side slopes between Canyon

Figure 5.—**Canyon complex, 18 to 40 percent slopes.**

and Oglala soils. Goshen soils are on foot slopes and the very narrow bottoms of ravines. In the northwestern part of the county, small areas of Anselmo, Holt, Tassel, and Vetal soils occur in some areas.

All areas of this complex are in native vegetation and are used for grazing. Ponderosa pine trees grow in scattered, thin stands, mostly on north-facing slopes. These trees provide protection for livestock and game animals and are sources of fenceposts and firewood.

Controlling erosion is the main concern in managing these soils. Erosion starts easily around the barren rock outcrops, along livestock trails, or any place where the plant cover is not adequate for protection. The steep irregular slopes and the rock outcrops make seeding by machine and other mechanical practices impractical. Proper range use is the most practical way to control erosion. (The Canyon soils are in the Shallow range site; capability unit VIIs-1; a windbreak suitability group is not assigned; Rock outcrop is in capability unit VIIIs-1, but is not assigned a range site or a windbreak suitability group)

Canyon-Oglala complex, 18 to 40 percent slopes (CoF).—This hilly complex occupies the sides of buttes, ridges, and valleys in the northern part of the county. This complex has more uniform slopes than Canyon complex, 18 to 40 percent slopes, and has few or no rock outcrops. Many of the irregularly shaped areas are more than 500 acres in size. Canyon soils make up 40 to 70 percent of the complex; Oglala soils, 20 to 40 percent; and other soils, 10 to 20 percent.

Canyon soils are steep and occur on the upper parts of slopes. Oglala soils are more gently sloping and occur on the mid and lower parts of slopes. Each kind of soil has a profile similar to the one described as typical for its respective series.

Small areas of Colby and Rosebud soils occur throughout the complex. Colby soils are on some of the wider ridgetops or on side slopes between Canyon and Oglala soils. The Goshen, Keith, and Ulysses soils occur in some areas.

All of this complex is in native grasses and is used for grazing. Stands of pine trees are scattered on some of the north-facing slopes but are not so common as on Canyon complex, 18 to 40 percent slopes. The steep slopes and shallow soils make this Canyon-Oglala complex unsatisfactory for cultivation. Gullies form easily where the plant cover is disturbed, and seeding and other mechanical practices are not practical on the Canyon part. Erosion is best controlled by proper range use. (The Canyon soils are in the Shallow range site and capability unit VIIs-1, but a windbreak suitability group is not assigned; the Oglala soils are in the Silty range site, capability unit VIe-1, and windbreak suitability group 2)

Canyon-Rock outcrop complex (18 to 40 percent slopes) (Cr).—This hilly complex occupies the sides of ridges and buttes that are high on the landscape, in contrast to the V-shaped canyons occupied by Canyon complex, 18 to 40 percent slopes. The Canyon soils make up 50 to 80 percent of this complex; Rock outcrop, 15 to 30 percent; and other soils, 5 to 30 percent. This complex is in the northern part of the county.

Canyon soils generally are closely associated with outcrops of sandstone on the steep side slopes. Some areas of Rock outcrop on ridgetops are as much as 20 acres in size (fig. 6). Small areas of Colby, Oglala, Rosebud, and Ulysses soils also occur in this complex. The Oglala soil is the most common of these soils and occupies the lower, more gentle slopes.

All of this complex is in native grasses. Because of its position on the high ridges, the complex provides little

Figure 6.—**Rock outcrop in Canyon-Rock outcrop complex.**

protection for livestock and most areas are used only for summer grazing.

Controlling erosion is the main management concern. Gullies form easily along livestock trails and where the plant cover is disturbed. Seeding and other mechanical practices are not feasible in most areas. Proper range use is the most practical way to control erosion. (The Canyon soils are in the Shallow range site and capability unit VIIs–1, but a windbreak suitability group is not assigned; Rock outcrop is in capability unit VIIIs–1, but a range site or a windbreak suitability group is not assigned)

Canyon-Rosebud complex, 3 to 12 percent slopes, eroded (CyD2).—This complex is on low-lying ridges and knolls of the uplands, mainly in the central and western parts of the county. Areas are irregular in shape and generally are less than 10 acres in size. Canyon soils make up to 90 percent of the complex, and Rosebud soils, 10 to 40 percent.

The Canyon soils occur on the tops and upper slopes of the ridges and knolls. Erosion has removed all or most of the thin, dark-colored surface layer, or this layer has been mixed with the subsoil by plowing. As a result, the present surface layer is light gray to white. Numerous sandstone fragments are on the surface.

The Rosebud soils are on the mid and lower slopes or are on ridge saddles between areas of Canyon soils. Erosion has removed part of the surface layer in some places, and in other places the dark-colored surface layer has been buried under as much as 6 inches of light-colored material that eroded from adjacent Canyon soils. In most areas the Rosebud soils have slopes of 5 to 9 percent.

All of this complex is cropland. Winter wheat, oats, barley, corn, and alfalfa are grown, and some areas have been seeded to tame grasses. Crops, however, grow poorly on the Canyon soils.

Erosion is the main management concern on these soils. The small irregularly shaped areas generally are within larger areas of productive soils and are a nuisance to management. In places where contour tillage or contour stripcropping is used, some areas can be seeded to native grass. (The Canyon soils are in the Shallow range site and capability unit VIs–2, but a windbreak suitability group is not assigned; the Rosebud soils are in the Silty range site, capability unit IIIe–1, and windbreak suitability group 2)

Colby Series

The Colby series consists of gently sloping to rolling, thin, silty soils that are calcareous. These soils formed in silty loess and occupy the tops of well-rounded ridges and knolls of the uplands.

In a typical profile the surface layer is gray silt loam about 2 inches thick. Just below is a transitional layer of grayish-brown silt loam about 3 inches thick that is slightly hard when dry and friable when moist. The underlying material is calcareous, light-gray and light brownish-gray silt loam to a depth of about 60 inches.

Colby soils are somewhat excessively drained. Surface runoff is medium to rapid, and permeability is moderate. Colby soils have a moderate water-holding capacity but are low in organic-matter content and natural fertility. They are easily worked and respond well to management. These limy soils wash and blow easily.

Most areas of the Colby soils are in native mid and short grasses and are used for grazing. Some areas are in cultivated crops, mainly winter wheat and alfalfa.

In this county Colby soils are mapped only in a complex with Keith soils.

Typical profile of a Colby silt loam in native grasses, 2,390 feet west and 550 feet south of the northeast corner, section 19, T. 38 N., R. 40 W.:

A1—0 to 2 inches, gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) when moist; weak, fine, granular structure; soft, very friable; mildly alkaline; abrupt, smooth boundary.

AC—2 to 5 inches, grayish-brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) when moist; weak, fine, subangular blocky structure breaking to weak, fine, granular structure; slightly hard, friable; mildly alkaline; abrupt, wavy boundary.

C1—5 to 12 inches, light brownish-gray (10YR 6/2) silt loam, grayish brown (10YR 5/2) when moist; weak, coarse, prismatic structure breaking to weak, medium and fine, subangular blocky structure; slightly hard, friable; calcareous; mildly alkaline; clear, wavy boundary.

C2—12 to 60 inches, light-gray (10YR 7/2) silt loam, grayish brown (10YR 5/2) when moist; structureless; soft, friable; few, fine, brownish-yellow to yellowish-brown iron stains; calcareous; moderately alkaline.

The A horizon ranges from 1 to 4 inches in thickness and from gray to grayish brown in color. The AC horizon generally is calcareous. It ranges from 3 to 8 inches in thickness and has weak structure that is prismatic or subangular blocky. These soils are calcareous within 5 inches of the surface under grasses and are calcareous throughout when cultivated.

Colby soils are lighter colored and are calcareous nearer the surface than Keith and Ulysses soils. The underlying material in Colby soils is softer than that in Canyon and Epping soils and does not contain fragments of sandstone or siltstone.

Dawes Series

In the Dawes series are deep, nearly level and gently sloping, silty soils that have a moderately thick to thick surface layer and a claypan in the subsoil. These soils occupy swales, stream terraces, and flats in the uplands. They formed in silty materials that, in some places, consist partly of local alluvium.

In a typical profile the surface layer is silt loam about 11 inches thick. It is dark gray to a depth of 6 inches and gray below that depth.

The subsoil is about 21 inches thick. The upper part is grayish-brown clay. The middle is grayish-brown clay loam. These two parts are very hard when dry and very firm when moist. The lower part is light brownish-gray and grayish-brown silt loam that is hard and slightly hard when dry and is firm and friable when moist. It has a few streaks and spots of soft lime and is calcareous.

The underlying material is light-gray and light brownish-gray silt loam that is calcareous and has common threads and seams of soft lime.

Dawes soils are moderately well drained. Surface runoff and permeability are slow. The capacity of these soils to hold water is high, but the release of moisture to plants is slow in the claypan. These soils have moderate natural fertility and a surface layer that is easily worked, but the claypan restricts the movement of water and the penetration of deep-rooted plants.

The native vegetation on Dawes soils is mid and short grasses. In the central part of the county, many areas of these soils are cultivated. The crops grown are winter wheat, oats, barley, alfalfa, and tame grasses. These crops grow moderately well, but row crops are not suitable.

Typical profile of a Dawes silt loam in a cultivated field, 35 feet south and 300 feet east of the fifth telephone pole south of the northwest corner, section 8, T. 36 N., R. 37 W. (Laboratory No. 8904–8913):

Ap—0 to 6 inches, dark-gray (10YR 4/1) silt loam, black (10YR 2/1) when moist; weak, fine, granular structure; soft, friable; neutral; abrupt, smooth boundary.

A12—6 to 9 inches, gray (2.5Y 5/1) silt loam, very dark grayish brown (2.5Y 3/2) when moist; very dark brown ped coats (2.5Y 2/2) when moist; weak, fine, granular structure; soft, friable; neutral; gradual, smooth boundary.

A2—9 to 11 inches, gray (2.5Y 6/1) silt loam, dark grayish brown (2.5Y 4/2) when moist; grayish-brown (2.5Y 5/2) ped coats, very dark brown (2.5Y 2/2) when moist; weak, fine, granular structure; slightly hard, friable; neutral; abrupt, smooth boundary.

B21t—11 to 17 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) when moist; gray (2.5Y 5/1) ped coats, very dark gray (2.5Y 4/1) when moist; strong, medium and fine, prismatic structure breaking to strong, medium and fine, blocky structure; very hard, very firm; thin, distinct, and continuous clay films on all ped faces; mildly alkaline; gradual; smooth boundary.

B22t—17 to 22 inches, grayish-brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) when moist; moderate, medium and fine, prismatic structure breaking to moderate, medium and fine, blocky structure; very hard, very firm; thin, continuous clay films on all ped faces; moderately alkaline; clear, smooth boundary.

B31ca—22 to 27 inches, light brownish-gray 2.5Y 6/2) silt loam, olive brown (2.5Y 4/3) when moist; weak, medium and coarse, prismatic structure breaking to moderate, medium and fine, subangular blocky structure; hard, firm; thin, continuous clay films on prism faces and thin, patchy clay films on block faces; calcareous with few, fine, soft lime segregations; strongly alkaline; gradual, smooth boundary.

B32ca—27 to 32 inches, grayish-brown (2.5Y 5/2) silt loam, light olive brown (2.5Y 5/3) when moist; weak, medium and coarse, prismatic structure breaking to weak, medium and fine, subangular blocky structure; slightly hard, friable; thin, very patchy clay films; calcareous; few fine segregations of soft lime; moderately alkaline; gradual, smooth boundary.

C1ca—32 to 39 inches, light brownish-gray (2.5Y 6/2) silt loam, light olive brown (2.5Y 5/3) when moist; massive; slightly hard, friable; calcareous; common threads and seams of segregated soft lime; moderately alkaline; gradual, smooth boundary.

C2ca—39 to 47 inches, light-gray (2.5Y 7/2) silt loam, light olive brown (2.5Y 5/3) when moist; massive; slightly hard, very friable; calcareous; common threads and seams of segregated soft lime; moderately alkaline; gradual, smooth boundary.

C3ca—47 to 60 inches, light brownish-gray (2.5Y 6/2) silt loam, light olive brown (2.5Y 5/3) when moist; massive; slightly hard, very friable; calcareous; few threads and seams of segregated soft lime; moderately alkaline.

The A horizon ranges from 8 to 18 inches in thickness. It generally is silt loam, but it is loam in places. The gray lower part has weak, subangular blocky structure in some places. The B horizon ranges from 16 to 36 inches in thickness. The B21t horizon ranges from dark gray to grayish brown in color and from clay loam or silty clay loam to clay or silty clay in texture. The clay content of the B21t horizon ranges from 36 to 45 percent. Depth to lime ranges from 20 to 36 inches. The C horizon normally is silt loam, but in places it changes abruptly to loamy material at a depth below 50 inches.

Dawes soils have a more compact clayey subsoil than Goshen or Keith soils. The Dawes soils have a distinct A2 horizon that Richfield soils lack. Dawes soils contain less salts than Mosher soils.

Dawes-Keith complex, 0 to 3 percent slopes (DkA).—This complex mostly occurs on terracelike benches in the southeastern part of the county and near the village of Tuthill. Areas are as much as 500 acres in size. Dawes soils make up 65 to 80 percent of the complex; Keith soils, 20 to 35 percent; and other soils, less than 10 percent.

These soils are closely intermingled. The Dawes soils occupy the more nearly level and the slightly concave parts of the landscape. Keith soils are on slight rises. The surface layer in each kind of soil includes silt loam and loam textures. Near the village of Tuthill, each kind of soil has a profile that is less silty than that described as typical for its respective series. In this area both Dawes and Keith soils are underlain by gray fine sand at a depth below 40 inches. This sand normally is noncalcareous, and it contains a few fine pebbles in places.

Included with these soils in mapping are small areas of Altvan, Hoven, Richfield, and Ulysses soils. Altvan soils occur where the sand and gravel is at a depth of less than 40 inches. In most places these areas are at the edge of terraces. Hoven soils occupy wet spots where water ponds. Ulysses soils occur on slight rises with Keith soils in some areas. Richfield soils occur in an erratic pattern in places.

Most areas of this complex are cultivated. Winter wheat and alfalfa are the main crops and grow moderately well.

Conserving moisture and maintaining good tilth are the main management concerns on this complex. Control of soil blowing is secondary. The claypan subsoil in the Dawes soils hinders the penetration of roots and the release of moisture to plants. In dry years crops on the Dawes soils are the first affected by the insufficient moisture, and the wheatfields take on an uneven or ragged appearance. Management is needed that regularly adds organic matter so as to maintain good tilth and reduce the likelihood of crusting. (Dawes soils are in the Silty range site, capability unit IIIs–1, and windbreak suitability group 4; Keith soils are in the Silty range site, capability unit IIc–1, and windbreak suitability group 2)

Dawes-Richfield silt loams, 0 to 5 percent slopes (DrB).—This complex occupies upland flats and swales, mainly in the central and western parts of the county. In most areas slopes are less than 3 percent and are plane to concave. The 3 to 5 percent slopes occur where the complex fingers upward along heads of small drains. Areas generally are less than 60 acres in size, and many are less than 20 acres. Dawes soils make up 60 to 70 percent of the mapped acreage, and Richfield soils, 30 to 40 percent.

Dawes soils occupy the more nearly level and the more concave parts of the landscape. Richfield soils are on very slight rises. Each kind of soil is similar to that described as typical for its respective series.

Included with these soils in mapping are small areas of Goshen and Keith soils. In some places these included soils make up less than 5 percent of the mapped acreage, but in many places, they are absent.

More than half the acreage of these soils is cultivated. Winter wheat is the main crop, and oats, barley, and alfalfa are also grown. Areas in native grasses are used for grazing and hay.

Conserving moisture and maintaining good tilth are the main concerns of management. Control of soil blowing is secondary. The claypan subsoil of the Dawes soils limits the release of moisture and the penetration and development of roots. As a result, grainfields have an uneven or ragged appearance in years of low rainfall. In cultivated areas the surface layer of these soils tends to crust when dry. Management that makes good use of crop residues helps to conserve moisture and to improve tilth. (Dawes soil is in the Silty range site, capability unit IIIs–1, and windbreak suitability group 4; Richfield soil is in the Silty range site, capability unit IIc–1, and windbreak suitability group 2)

Dunday Series

The Dunday series is made up of deep, nearly level to gently undulating, sandy soils. These soils formed in eolian sands on uplands in the southern and eastern parts of the county.

In a typical profile the surface layer is dark-gray to dark grayish-brown loamy fine sand about 17 inches thick. Just below is a transitional layer about 19 inches thick. It consists of brown loamy fine sand that is soft and very friable. The underlying material is pale-brown loamy sand.

Dunday soils are somewhat excessively drained. Runoff is slow and permeability is rapid. These soils have moderate natural fertility, but they have low water-holding capacity and are subject to soil blowing.

The native vegetation on Dunday soils consists of tall grasses, mid grasses, and small amounts of short grasses. Most areas are still in grass and are used for grazing and hay. Small areas are cultivated mainly to spring-sown small grains, corn, and alfalfa.

Typical profile of a Dunday loamy fine sand in native grasses, 1,640 feet west and 240 feet north of the southeast corner, section 36, T. 38 N., R. 35 W.:

A11—0 to 4 inches, dark-gray (10YR 4/1) loamy fine sand, very dark gray (10YR 3/1) when moist; weak, fine, granular structure; soft, very friable; neutral; clear boundary.

A12—4 to 17 inches, dark grayish-brown (10YR 4/2) loamy fine sand, very dark grayish brown (10YR 3/2) when moist; weak, medium and coarse, prismatic structure breaking to weak, medium and fine, subangular blocky structure and single grain; soft, very friable; mildly alkaline; clear boundary.

AC—17 to 36 inches, brown (10YR 5/3) loamy fine sand, dark brown (10YR 4/3) when moist; very weak, coarse, prismatic structure; soft, very friable; mildly alkaline; gradual boundary.

C—36 to 60 inches, pale-brown (10YR 6/3) loamy sand, brown (10YR 5/3) when moist; single grain; loose; mildly alkaline.

The A horizon ranges from 8 to 24 inches in thickness and in places is loose and has very weak structure. In places it is black or very dark brown when moist. In places the AC horizon is structureless, loose, and intermediate in color between that of the upper layers and the underlying material. The C horizon ranges from loamy sand to sand. In places faint yellowish mottles are at a depth of about 55 inches.

Dunday soils have a darker and thicker surface layer than that in Valentine soils. They are more sandy than Anselmo soils and are better drained than Elsmere.

Dunday loamy fine sand, 0 to 6 percent slopes (DsB).—This soil occupies swales, valleys, and fans on uplands in the eastern part of the county. The areas are not in the sandhills and generally are more than 40 acres in size.

This soil has a profile similar to that described as typical for the series.

Included with this Dunday soil in mapping are small areas of Anselmo, Valentine, and Vetal soils. The Vetal soils are in low spots, and the Valentine soils are on small hummocks. These included soils normally make up less than 10 percent of the mapped acreage.

Most areas of these soils are in native grasses and are used for grazing and hay. Only a few, small fields are cultivated. Spring-sown grains, corn, and alfalfa are the main crops.

Control of soil blowing is the main concern in managing this soil. Proper use controls erosion in areas in native grasses, but in cropped areas a good cover of growing plants and crop residues are needed to control soil blowing. (Sandy range site; capability unit IVe-3; windbreak suitability group 1)

Dunday-Anselmo complex, 0 to 3 percent slopes (DtA).—This complex is on uplands in the eastern part of the county. In most places areas are more than 60 acres in size. Dunday soils occupy the slight rises and undulations in the landscape. Anselmo soils are on the more nearly level areas. The profile of each kind of soil is similar to that described as typical for its respective series.

Dunday soils make up 60 to 80 percent of the mapped areas; Anselmo soils, 20 to 40 percent; and other included soils less than 10 percent.

Included in some mapped areas are small tracts of Valentine and Vetal soils. Valentine soils are on small hummocks, generally in areas less than 2 acres in size. Vetal soils are in narrow swales.

More than one-half of the acreage of this complex is in native grasses and is used for grazing or hay. Oats, barley, corn, and alfalfa are the main crops grown. The risk of soil blowing makes it inadvisable to grow winter wheat, though this crop is grown in some places. Some areas that were cultivated in the 1930's have been seeded to tame grasses.

Control of soil blowing is the main concern in managing the soils in this complex. Where these soils are cultivated, content of organic matter decreases and the soils blow easily. Where the soils remain in native grasses, proper range use helps to control soil blowing, but cropped areas need intensive management that includes the use of crop residues and wind stripcropping. (The Dunday soils are in Sandy range site, capability unit IVe-3, windbreak suitability group 1; Anselmo soils are in Sandy range site, capability unit IIIe-2, windbreak suitability group 1)

Dunday-Anselmo complex, 3 to 9 percent slopes (DtC).—This gently undulating to undulating complex is on uplands in the eastern part of the county. Most areas are more than 60 acres in size. Some areas have the full range of 3 to 9 percent slopes, but other areas have slopes that are mostly 3 to 5 percent or 5 to 9 percent. Dunday soils make up 60 to 85 percent of the acreage mapped; Anselmo soils, 15 to 40 percent; and other soils, less than 10 percent.

Dunday soils are on the upper slopes of the ridges and knolls. Anselmo soils are on the lower side slopes and on the troughs between the ridges. Some of the cropland or former cropland shows varying degrees of soil blowing. In these areas, winnowing has left sand particles on the surface, and the surface layer is thinner than that described for the series.

Included with the Dunday and Anselmo soils in mapping are small areas of Valentine and Vetal soils.

Valentine soils are on the crests of the steeper, short-sloped ridges and knolls. Vetal soils occupy some of the troughs or swales. Small sand blowouts of as much as 2 acres occur in some places. Some of these blowouts are in formerly cultivated areas.

Most of this complex is in native grasses and is used for grazing. Some areas formerly in annual crops have been seeded to tame grass or have returned to native grasses. A few acres are cultivated to oats, barley, corn, and alfalfa.

Control of soil blowing is the main concern in management. Hard rains cause some washing on cultivated fields. Control of erosion is impracticable on this complex in areas where the dominant Dunday soil has slopes of 5 to 9 percent. Such areas are best suited for use as range. In the less sloping, cultivated areas, intensive management is needed to control soil blowing. (The Dunday soils are in the Sandy range site, capability unit VIe-2, and windbreak suitability group 1; Anselmo soils are in the Sandy range site, capability unit IIIe-2, and windbreak suitability group 1)

Dunday and Elsmere loamy fine sands (0 to 3 percent slopes) (Du).—These soils occupy basins and valleys in and near the sandhills. Most areas are more than 30 acres in size. Some of these areas are made up almost entirely of the Dunday soil, some are mostly the Elsmere soil, and some have large amounts of both soils.

The sandy material in valleys has been shifted enough by wind to make the surface uneven. The Dunday soil is on the high and dry areas which are at the outer edges of the valleys in many places. The Elsmere soil is in the low areas where the water table is at a depth between 3 and 6 feet.

Included with the Dunday and Elsmere soils in mapping are areas of Loup and Valentine soils less than 5 acres in size. The Valentine soil is on small hummocks at the edges of the valleys. The Loup soil occurs in some of the lowest spots. These inclusions make up less than 5 percent of the acreage mapped.

Most areas of these soils are in native grasses and are used for grazing and hay. Alfalfa is the main crop on the few cultivated areas.

The major management concerns are the seasonal rise of the water table in the Elsmere part of this mapping unit and the control of soil blowing in all parts. Use of these soils for grazing or hay is the most practical way of controlling soil blowing and of reducing the adverse effects of the occasional wetness. Cultivated areas require the use of close-sown crops and other practices that help to control blowing. (The Dunday soil is in the Sandy range site, capability unit IVe-3, and windbreak suitability group 1; Elsmere soil is in the Subirrigated range site; capability unit IVw-1; and windbreak suitability group 3)

Dunday-Valentine complex, 0 to 5 percent slopes (DvB).—This gently undulating complex occupies dry valleys and basins in the sandhills. In some areas the complex is at the outer edges of valleys that are occupied mainly by Dunday and Elsmere loamy fine sands. The

Dunday soils and the Valentine soils each make up about 40 to 60 percent of this complex.

The Valentine soils are on the rounded knolls and mounds, and the Dunday soils are on the intervening side slopes and swales. Each kind of soil has a profile similar to the one described as typical for its respective series.

Included with these soils in this mapping are areas of Elsmere soils and of sand blowouts. These included areas are less than 5 acres in size, and they make up less than 15 percent of the acreage mapped.

All of this complex is in native grasses and is used for grazing and hay. In most areas the Dunday soils are so intermingled with the Valentine soils that cultivation is not practical. Control of soil blowing is the main concern in management of these soils. Proper range use helps to control soil blowing. (Dunday soils are in the Sandy range site, capability unit IVe-3, and windbreak suitability group 1; Valentine soils are in the Sands range site, capability unit VIe-2, and windbreak suitability group 6)

Elsmere Series

This series consists of deep, sandy soils that have a seasonal high water table in some years. These soils are nearly level and gently undulating. They occupy basins and valleys that are mainly in and near the Valentine association in the southern part of the county. They formed in eolian and alluvial sands.

In a typical profile the surface layer, about 17 inches thick, is dark-gray loamy fine sand. Just below is a transitional layer of grayish-brown loamy fine sand about 6 inches thick. It is loose and very friable and has faint iron mottles. The underlying material is pale-brown to light-gray fine sand. It has distinct and faint iron mottles.

Elsmere soils are somewhat poorly drained. Early in the growing season, in some years, the water table rises to within 3 feet of the surface, but it generally drops to a depth of 4 feet or more during summer. Surface runoff is very slow, and permeability is rapid above the water table. Elsmere soils have low water-holding capacity, but the water table provides moisture for deep-rooted plants. These soils blow easily where the plant cover is disturbed.

The native vegetation on Elsmere soils is mainly tall and mid grasses. Most areas are in native grasses and are used for grazing and hay. Some areas are cultivated, and alfalfa is the main crop.

In this county Elsmere soils are mapped only with Dunday soils in an undifferentiated soil group.

Typical profile of an Elsmere loamy fine sand in native grasses, 600 feet south and 275 feet east of the northwest corner, section 22, T. 36 N., R. 40 W.:

A1—0 to 17 inches, dark-gray (10YR 4/1) loamy fine sand, very dark gray (10YR 3/1) when moist; very weak, fine, granular structure; loose, very friable; neutral; gradual boundary.

AC—17 to 23 inches, grayish-brown (10YR 5/2) loamy fine sand, dark grayish brown (10YR 4/2) when moist; structureless; loose, very friable, nonsticky; few, faint mottles; neutral; clear, smooth boundary.

C1—23 to 40 inches, pale-brown (10YR 6/3) fine sand, brown (10YR 5/3) when moist; structureless; loose, very friable, nonsticky; common, distinct, yellowish-brown (10YR 5/5) mottles and (10YR 5/8) when moist; neutral; clear, smooth boundary.

C2—40 to 60 inches, light-gray (10YR 7/2) fine sand, brown (10YR 5/3) when moist; structureless; loose, nonsticky; few, faint, mottles; neutral.

The A1 horizon ranges from 6 to 24 inches in thickness and, in places, is black or very dark brown when moist. The AC horizon ranges from 6 to 12 inches in thickness and from loamy fine sand to sand in texture. Depth to the water table ranges from 3 to 6 feet. In some places the C horizon is calcareous at a depth of 20 to 60 inches. Dark-colored layers of an older buried soil are common in some places.

Epping Series

This series consists of gently sloping to hilly, silty soils that are calcareous and shallow to bedded silt or siltstone. These soils of the uplands are in a few scattered areas along the northern county line.

In a typical profile the surface layer, about 3 inches thick, is light brownish-gray silt loam. This layer overlies calcareous, pinkish-gray silt loam that is about 4 inches thick and is slightly hard when dry and friable when moist. This layer contains bits and larger fragments of siltstone. Just below is pinkish-gray, bedded siltstone, which is calcareous.

Epping soils are somewhat excessively drained to excessively drained. Surface runoff is rapid, and permeability is moderately slow. Epping soils are low in organic-matter content and natural fertility. They are susceptible to water erosion and soil blowing.

The native vegetation on Epping soils is short and mid grasses. These soils are in native grasses and are used for grazing. Epping soils are not suited as cropland.

Typical profile of an Epping silt loam in native grasses, 2,540 feet north and 100 feet west of the southeast corner, section 4, T. 39 N., R. 37 W.:

A1—0 to 3 inches, light brownish-gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) when moist; weak, fine, granular structure; slightly hard, friable; calcareous; moderately alkaline; clear boundary.

C1—3 to 7 inches, pinkish-gray (7.5YR 7/2) silt loam, light brown (7.5YR 6/4) when moist; weak, medium, prismatic structure; slightly hard, friable; common bits and larger fragments of siltstone; calcareous; moderately alkaline; clear boundary.

C2—7 to 14 inches, pinkish-gray (7.5YR 7/2) bedded siltstone, light brown (7.5YR 6/4) when moist; calcareous; moderately alkaline.

The A1 horizon ranges from 2 to 4 inches in thickness and from light brownish gray to grayish brown in color. It is free of lime in some places, but in all places the soil is calcareous within a depth of 6 inches. In some places there is an AC horizon that, in color, is intermediate between the color of the A1 horizon and that of the C horizon. In many areas fragments of siltstone make up 5 to 30 percent of the soil mass, by volume. The bedded siltstone, or C2 horizon, is at a depth ranging from 6 to 20 inches. It varies in hardness but can be penetrated with a spade or auger in most places.

Epping soils, unlike the Kadoka soils, are limy at or near the surface, are more shallow to siltstone, and lack a clayey subsoil. They are more silty than Canyon and Tassel soils. The underlying materials in Epping soils are harder than those in Colby soils.

Epping complex, 9 to 40 percent slopes (EhF).—This complex is on uplands in small areas scattered along the north county line where drainageways have cut into siltstone materials. Most of the slopes are less than 20 percent. Epping soils make up 45 to 70 percent of the mapping unit; Kadoka soils, 15 to 40 percent; and other soils, about 15 percent.

Epping soils occupy the ridgetops and the steeper slopes, and Kadoka soils are on the mid and lower slopes. The Kadoka soils in this complex have a thinner surface layer and subsoil than corresponding layers in the profile described as typical for the Kadoka series.

Small areas of Rock outcrop occur on the upper part of the steeper slopes. Other soils in some mapped areas are Colby, Goshen, and Ulysses soils. Goshen soils are along upland drainageways, and Colby and Ulysses soils are on rounded ridgetops.

All areas of this complex are in native grasses and are used for grazing. Pine and cedar are scattered on some north-facing slopes.

These soils wash and gully when the plant cover is disturbed. Management is needed that maintains the grass cover so as to help control erosion. Seeding and other mechanical practices are feasible only on slopes of less than 18 percent. (The Epping soils are in the Shallow range site and capability unit VIs–2, but a windbreak suitability group is not assigned; the Kadoka soils are in the Silty range site, capability unit VIe–1, windbreak suitability group 2)

Gannett Series

In the Gannett series are deep, very poorly drained soils that occupy the lowest parts of basins and valleys of the sandhills in the southern part of Bennett County. These soils have a high water table most of the year.

At the surface of a typical profile is a soft, spongy peaty layer that is about 4 inches thick and is very dark grayish brown when moist. The dark-gray surface layer, about 15 inches thick, is black when moist. The part of the surface layer just below the organic material is fine sandy loam. The lower part is loam that contains very thin seams of loamy sand. The underlying material, a gray fine sand, is saturated with free water.

Gannett soils have no surface runoff. The water table is at or near the surface during much of the growing season and rarely drops to a depth below 20 inches. These soils are high in organic-matter content but are poorly aerated.

The native vegetation consists of sedges, rushes, and tall and mid water-tolerant grasses. All areas are in native vegetation and are used mainly for hay. In most years the water table drops enough late in summer to permit haying.

Typical profile of Gannett fine sandy loam in native grass meadow, 1,840 feet east and 350 feet north of the southwest corner, section 17, T. 35 N., R. 33 W.:

O1—4 inches to 0, dark-gray (10YR 4/1) peat, very dark grayish brown (10YR 3/2) when moist; soft, spongy; neutral; abrupt, wavy boundary.

A11g –0 to 7 inches, dark-gray (N 4/0) fine sandy loam, black (10YR 2/1) when moist; weak, thick and very thick, platy structure; very friable, slightly sticky; fine streaks of dark-brown fibrous peat; neutral; abrupt, irregular boundary.

A12g—7 to 15 inches, dark-gray (N 4/0) loam, black (10YR 2/1) when moist; weak, coarse, prismatic structure; friable, sticky; very thin seams of loamy sand; neutral; abrupt, irregular boundary.

Cg—15 to 60 inches, light-gray (10YR 5/1) fine sand, gray (10YR 5/1) when moist; structureless; loose, nonsticky; neutral.

The peaty layer ranges from 2 to 6 inches in thickness. The A1 horizon ranges from 7 to 20 inches in thickness and mostly from fine sandy loam to loam in texture. In some places the underlying material has dark-gray, buried layers that resemble muck. Some profiles have layers of greenish-gray sandy clay loam in the underlying sand.

Gannett soils have a peaty layer at the surface and are more poorly drained than Lamo and Loup soils, which have mineral layers at the surface.

Gannett fine sandy loam (0 to 2 percent slopes) (Ga).—This very poorly drained soil occupies the lowest parts of sandhill basins and valleys. In many places this soil is in areas adjacent to sandhill lakes and marshes. Most of the areas are more than 20 acres in size. This soil has the profile described as typical for the series. Included with this soil in mapping are small areas of Marsh and of a Loup soil. These inclusions make up less than 15 percent of the mapped areas.

All of this soil is in native vegetation and is used mostly as hay meadow. Some areas are grazed. Tame grasses and red clover have been added in some areas to improve the quality of the plants grown for forage.

Wetness makes this soil unsuitable for cultivation, but the water table usually drops enough late in summer to permit haying. (Wetland range site; capability unit Vw–1; windbreak suitability group 3)

Goshen Series

In the Goshen series are deep, nearly level and gently sloping, silty soils that formed in alluvium washed down from adjacent slopes. These soils occupy swales, foot slopes, and fans on the uplands in all parts of the county except the sandhills.

In a typical profile the dark-gray surface layer, about 11 inches thick, is silt loam in the upper part and is silty clay loam below.

The subsoil is about 44 inches thick. It is dark-gray and gray, friable and firm silty clay loam in the upper part; gray and grayish-brown, friable and firm clay loam in the middle part; and grayish-brown, friable loam in the lower part. The grayish-brown loam is a transitional layer that contains distinct threads and seams of segregated lime and is calcareous.

Goshen soils are moderately well drained. Surface runoff is slow because these soils are in areas that collect runoff from adjacent slopes. Permeability is moderate. Goshen soils have high water-holding capacity, are high in natural fertility, and have good tilth.

The native vegetation on Goshen soils consists mainly of mid and tall grasses, but some short grasses grow. Most areas of Goshen soils in the central part of the county are cropland. Winter wheat is the main crop. Crops grow well. Some areas are in native grasses and are used for grazing and hay.

Typical profile of Goshen silt loam, 0 to 3 percent slopes, in a cultivated field, 2,100 feet east and 100 feet south of the northwest corner, section 6, T. 37 N., R. 39 W. (Laboratory No. 8885–8893):

Ap—0 to 7 inches, dark-gray (10YR 4/1) silt loam, black (10YR 2/1) when moist; weak, fine, granular structure; soft, friable; slightly acid; abrupt, smooth boundary.

A12—7 to 11 inches, dark-gray (10YR 4/1) silty clay loam, black (10YR 2/1) when moist; very weak, medium and coarse, prismatic structure breaking to weak, fine, granular structure; hard, friable; thin, very patchy clay films

on vertical prism faces; common fine and few medium pores; slightly acid; clear, smooth boundary.

B1—11 to 17 inches, dark-gray (10YR 4/1) silty clay loam, black (10YR 2/1) when moist; weak, medium, prismatic structure breaking to weak, fine, subangular blocky structure and fine granular structure; hard, friable; thin, very patchy clay films on all ped faces; common fine and few medium pores; slightly acid; gradual, smooth boundary.

B21t—17 to 24 inches, dark-gray (10YR 4/1) silty clay loam, very dark gray (10YR 3/1) when moist; weak, medium, prismatic structure breaking to moderate, fine, subangular blocky structure; hard, friable to firm; thin, continuous clay films on all ped faces; common fine and few medium pores; few worm casts and filled worm channels; slightly acid; gradual, smooth boundary.

B22t—24 to 31 inches, gray (10YR 5/1) silty clay loam, dark gray (10YR 4/1) when moist; moderate, medium, prismatic structure breaking to moderate and strong, medium and fine, subangular blocky structure; very hard, firm; thin, distinct, continuous clay films on ped faces; few fine pores; few worm casts and filled worm channels; slightly acid; gradual, smooth boundary.

B23t—31 to 38 inches, gray (10YR 5/1) clay loam, very dark gray (10YR 3/1) when moist; weak to moderate, medium, prismatic structure breaking to moderate, medium and fine, subangular blocky structure; very hard, firm; thin, continuous clay films on ped faces; common fine and few medium pores; few worm casts and filled worm channels; neutral; gradual, smooth boundary.

B31—38 to 44 inches, gray (10YR 5/1) clay loam, very dark brown (10YR 2/2) when moist; weak, medium and coarse, prismatic structure breaking to weak, medium and fine, subangular blocky structure; very hard, friable; thin continuous and patchy clay films on ped faces; common fine and few medium pores; few to common worm casts and filled worm channels; neutral; gradual, smooth boundary.

B32—44 to 49 inches, grayish-brown (10YR 5/2) clay loam, very dark gray (10YR 3/1) when moist; very weak, medium and coarse, prismatic structure breaking to moderate and weak, medium and fine, subangular blocky structure; very hard, friable; thin continuous clay films; common worm casts and filled worm channels; neutral; clear, smooth boundary.

B33ca—49 to 55 inches, grayish-brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) when moist; weak, medium and fine, subangular blocky structure; very hard, friable; common worm casts and filled worm channels; calcareous with few to common, fine, distinct threads and seams of segregated lime; mildly alkaline.

The A horizon ranges from 8 to 18 inches in thickness and from dark gray or gray to dark grayish brown in color. Texture is silt loam or light silty clay loam or loam in some places. The B horizon ranges from 17 to 44 inches in thickness and is dark colored to a depth of 20 inches or more. In places the lower part of the B horizon is calcareous. Normally a C horizon is below the B horizon. It is light-colored, calcareous silt loam. In places it changes abruptly to calcareous, loamy materials containing gritty bits of sandstone.

Goshen soils generally have thicker dark-colored horizons than the associated Keith, Richfield, and Rosebud soils. Goshen soils have a less clayey subsoil than Dawes soils and are better drained and less clayey than the Hoven soils.

Goshen silt loam, 0 to 3 percent slopes (GoA).—This soil occupies upland swales, mainly in the central and western parts of the county. Many areas are narrow and irregularly shaped, but some areas are broad and more than 50 acres in size. The profile of this soil is that described as typical for the series.

Included with this soil in mapping are small areas of Dawes, Keith, Oglala, Richfield, Rosebud, and Hoven soils. The Hoven soils occur as small spots in some of the broad areas, and the other included soils occur on the outer edges of the mapping unit. All of these included soils make up less than 10 percent of the mapped area.

Most of this soil is cropland. Winter wheat is the main crop, and oats, barley, corn, soghums, and alfalfa also are grown. Crops grow well on this soil. This soil occurs in places that usually are moist, and crops are affected by a shortage of moisture only during prolonged dry periods. In wet years, small grains tend to lodge.

Although erosion is not a hazard on this soil, in some areas management is needed that lessens deposition of materials eroded from adjacent slopes. (Overflow range site; capability unit IIc-1; windbreak suitability group 2)

Goshen silt loam, 3 to 6 percent slopes (GoB).—This soil is mostly on fans and benches between rolling uplands and the Little White River. Most areas are less than 30 acres in size. The profile of this soil is similar to the one described as typical for the series except that, in some places, this soil has a less clayey subsoil.

Included in some mapped areas are small tracts of Keith, Oglala, and Rosebud soils. These included soils make up less than 10 percent of the mapping unit.

Most of this Goshen soil is cropland. Winter wheat and alfalfa, the main crops, grow well on this soil.

Control of water erosion is the main concern of management. Runoff water causes most of the damage and generally comes from adjacent, steeper slopes. (Silty range site; capability unit IIe-1; windbreak suitability group 2)

Gravelly Land

Gravelly land (9 to 40 percent slopes) (Gr) consists of mixed gravelly soils and soil materials that occupy rounded knolls and ridges on the uplands, mostly in the northeastern part of the county. In most areas slopes are less than 20 percent. Most areas are less than 40 acres in size. The mixed soils have gravelly surface layers that range from sandy loam to loam in texture. On the ridgetops and steeper side slopes the soils are shallow to gravel and sand. On some side slopes, however, the soils have a surface layer of gravelly loam and a subsoil that generally is similar to the subsoil in the adjacent Keith and Rosebud soils.

Included with this land type in mapping are areas of Canyon and Tassel soils.

Almost all areas are in native grasses and are used for grazing. Some areas on the foot slopes are cultivated. Management is needed that maintains a good plant cover so as to help control erosion.

Proper range use is a good way to maintain a good grass cover. In some areas seeding and other mechanical practices are feasible, but most areas of this land type are too gravelly or too sloping for such practices. (Shallow range site; capability unit VIIs-1; windbreak suitability group not assigned)

Haverson Series

The Haverson series consists of deep, nearly level, loamy soils that formed in alluvium on bottom lands.

In a typical profile the surface layer is grayish-brown very fine sandy loam about 6 inches thick. The next layer

is transitional and about 10 inches thick. It is grayish-brown and light brownish-gray very fine sandy loam that is soft to slightly hard when dry and friable to very friable when moist. The underlying material, in sequence downward, is light-gray very fine sandy loam, light-gray loam, light brownish-gray silt, and white silt. This layer is calcareous alluvium.

Haverson soils are moderately well drained to well drained. Surface runoff is slow, and permeability is moderate to moderately rapid. In these soils water-holding capacity is moderate, and natural fertility is low to moderate. Where these soils are on the low bottom lands, they are flooded in some years; but on the other bottom lands, they are rarely flooded. Many areas have a water table at a depth of 10 to 20 feet.

The native vegetation on Haverson soils is tall, mid, and short grasses. In most areas thickets of native trees and shrubs are scattered along the stream channel. Many areas are in native grasses and are used for grazing and hay. Some areas are cropland, and alfalfa is the main crop.

Typical profile of Haverson loam, 0 to 3 percent slopes, in native grasses, 2,100 feet west and 1,100 feet south of the northeast corner, section 5, T. 39 N., R. 37 W.:

A1—0 to 6 inches, grayish-brown (10YR 5/2) very fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft, very friable; mildly alkaline; clear, smooth boundary.

AC1—6 to 9 inches, grayish-brown (10YR 5/2) very fine sandy loam, dark grayish brown (10YR 4/2) when moist; very weak, coarse, prismatic structure; soft, very friable; mildly alkaline; clear, smooth boundary.

AC2—9 to 16 inches, light brownish-gray (10YR 6/2) very fine sandy loam, dark grayish brown (10YR 4/2) when moist; very weak, coarse, prismatic structure; slightly hard, friable; moderately alkaline; abrupt, wavy boundary.

C1—16 to 24 inches, light-gray (10YR 7/2) very fine sandy loam, grayish brown (10YR 5/2) when moist; very weak, coarse, prismatic structure; slightly hard, friable; calcareous; moderately alkaline; gradual boundary.

C2—24 to 45 inches, light-gray (10YR 7/2) loam, light brownish gray (10YR 6/2) when moist; massive; hard, friable; calcareous; moderately alkaline; abrupt boundary.

C3—45 to 50 inches, light brownish-gray (10YR 6/2) silt loam, grayish brown (10YR 5/2) when moist; massive; slightly hard, friable; calcareous; strongly alkaline; clear boundary.

C4—50 to 60 inches, white (10YR 8/2) silt loam, light gray (10YR 7/2) when moist; slightly hard, friable, massive; slightly hard, friable; calcareous; strongly alkaline.

The surface layer ranges from 5 to 11 inches in thickness and from dark gray to grayish brown in color. The transitional layer ranges from 6 to 15 inches in thickness, and its color is intermediate between that of the surface layer and of the underlying material. The texture of the transitional layer and of the underlying material ranges from very fine sandy loam to silt. Depth to lime ranges from 12 to 30 inches. The C horizon normally is stratified in texture, and buried, dark-colored layers are common.

Haverson soils are less sandy than Bankard soils. They are lighter colored than Lamo soils and do not have a water table within 6 feet of the surface. Haverson soils are not so well drained as Colby soils, and they formed in materials of less uniform texture.

Haverson loam, 0 to 3 percent slopes (HaA).—This soil is on bottom lands and generally occurs in narrow, irregularly shaped areas. Most of these areas are less than 40 acres in size. This soil has the profile described as typical for the series.

Included with this soil in mapping are small areas of Mosher soils. Also included are narrow strips of mixed alluvium that occurs along some stream channels and is similar to the soil material in Alluvial land.

More than half of this soil is in native grasses and is used for grazing and hay. In cultivated areas alfalfa grows well and is the main crop. Scattered clumps of trees and shrubs provide cover for wildlife.

This soil is flooded by stream overflow about 1 year in 5. The main damages from flooding are broken fences and some accumulation of sediments and trash. A way to minimize damage from flooding is by using this soil for alfalfa or native hay. (Overflow range site; capability unit IIw-1; windbreak suitability group 2)

Holt Series

In the Holt series are moderately deep, nearly level to moderately steep soils that occur on uplands mostly in the eastern and northeastern parts of the county. These soils formed in materials weathered from the underlying, weakly cemented sandstone. In some places the upper part of the soils is formed in materials reworked by wind.

In a typical profile the surface layer is dark grayish-brown fine sandy loam about 7 inches thick. The subsoil, about 17 inches thick, is brown sandy loam and fine sandy loam that are hard or slightly hard when dry and friable when moist. Sandstone pebbles are common between depths of 17 and 24 inches. The underlying material is light-gray, calcareous, soft, bedded sandstone that contains bits and larger fragments of more resistant sandstone.

Holt soils are well drained. Runoff is slow and permeability is moderately rapid. The water-holding capacity and natural fertility are moderate. Holt soils are easily susceptible to soil blowing when they are not protected by vegetation, and cultivated areas on slopes are easily water eroded when they are unprotected by crops.

The native vegetation on Holt soils is a mixture of tall, mid, and short grasses. Many areas are still in native grasses and are used for grazing and hay. Some of the gentler slopes are cropland. Spring-sown small grains, corn, and alfalfa are the main crops grown on these soils.

Typical profile of a Holt fine sandy loam in native grasses, 1,840 feet north and 100 feet west of the southeast corner, section 9, T. 39 N., R. 36 W.:

A11—0 to 4 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark brown (10YR 2/2) when moist; weak, fine, granular structure; soft, very friable; neutral; clear, smooth boundary.

A12—4 to 7 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, prismatic structure breaking to weak, medium, subangular blocky structure and fine granular structure; soft, friable; neutral; clear, smooth boundary.

B2t—7 to 17 inches, brown (10YR 5/3) sandy loam, dark brown (10YR 3/3) when moist; moderate, medium and coarse, prismatic structure breaking to moderate, medium, subangular blocky structure; hard, friable; thin, continuous clay films on vertical faces and thin, patchy clay films on horizontal faces; neutral; gradual, smooth boundary.

B3—17 to 24 inches, brown (10YR 5/3) fine sandy loam, dark brown (10YR 4/3) when moist; weak, medium, very coarse, prismatic structure breaking to very weak, medium, subangular blocky structure; slightly hard, friable; common fragments of calcareous sandstone as much as 3 inches in diameter make up about 10 percent of soil mass; neutral; abrupt boundary.

C1ca—24 to 48 inches, light-gray (10YR 7/2), soft, bedded sandstone, grayish brown (10YR 5/2) when moist; massive; slightly hard, very friable; fine gritty bits and larger fragments of more resistant sandstone make up about 5 percent of the mass; calcareous; moderately alkaline; gradual boundary.

C2—48 to 60 inches, light-gray (10YR 7/2), soft, bedded sandstone, grayish brown (10YR 5/2) when moist; crushes to very fine sand; loose; calcareous; moderately alkaline.

The A horizon ranges from 4 to 8 inches in thickness, from dark gray to grayish brown in color, and from sandy loam to very fine sandy loam in texture. The B horizon ranges from 7 to 20 inches in thickness and is dark colored in the upper part in some places. Depth to the soft, bedded sandstone ranges from 20 to 40 inches, but depth to lime ranges from 15 to 30 inches. The sandstone is unconsolidated in most places and can be penetrated easily with a spade or auger. In some places, however, the sandstone is moderately cemented and is difficult to penetrate with either tool.

Holt soils are darker colored than Tassel soils, have a more distinct subsoil, and are deeper to standstone. They are more sandy than Rosebud soils. In the Holt soils the material just below the surface layer is more coherent than that in Anselmo soils. Holt soils formed in material weathered from weakly cemented sandstone, and Anselmo soils formed in sandy material that has been modified by wind. The subsoil in the Holt soils is less clayey than that in the Tuthill soils.

Holt and Tuthill fine sandy loams, 0 to 5 percent slopes (HtB).—These soils occur on uplands in the eastern and northeastern parts of the county. Areas are as much as 250 acres in size. In most areas Holt and Tuthill soils both are present in varying amounts. The Holt soil is the main soil in a few areas, and in a few areas the Tuthill soil is dominant.

In the areas where both soils are present, the Holt soil is on the higher, more convex slopes. The Tuthill soil is on the lower parts of side slopes, which in many places are plane to concave in shape. Each soil is similar to that described as typical for its respective series. In some cultivated areas of this undifferentiated unit, wind has winnowed the sand particles on the surface and the surface layer is loose.

Included with these Holt and Tuthill soils in mapping are small areas of Anselmo, Tassel, and Vetal soils. The Anselmo soil is scattered in spots where wind has modified the surface. The Tassel soil occupies small spots on some of the low-lying ridges where sandstone is close to the surface. The Vetal soil is on foot slopes and in upland swales.

Much of this complex is in native grasses and is used for grazing and hay. In cultivated areas oats, barley, corn, and alfalfa are the main crops. Some winter wheat also is grown.

Soil blowing is the main concern of management on these soils. Where these soils are cultivated, the content of organic matter decreases and the soil blows easily. Use of crop residues, stubble mulching, and wind stripcropping help to control soil blowing. (Sandy range site; capability unit IIIe–2; windbreak suitability group 1)

Holt and Tuthill fine sandy loams, 5 to 9 percent slopes (HtC).—The soils in this mapping unit occupy sloping uplands in the eastern and northeastern parts of the county. Areas are as much as 500 acres in size. Holt and Tuthill soils are present in varying amounts in most areas, but a few areas are made up mostly of the Holt soil.

The Holt soil is on the higher and generally more convex slopes. The Tuthill soil is on the lower part of the longer slopes. Each soil is similar to the one described as typical for its respective series, except that in some cultivated areas where water erosion and soil blowing have removed part of the surface layer, the remaining part is structureless and loose.

Included with these Holt and Tuthill soils in mapping are small areas of Anselmo, Tassel, and Vetal soils. The Anselmo soil occurs where the surface has been modified by wind. The Tassel soil is on the crest of some ridges where sandstone is close to the surface. The Vetal soil is on foot slopes and in concave swales on uplands.

Most areas of these soils are in native grasses and are used for grazing. A few small fields are cultivated. Oats, barley, and alfalfa are the main crops, and some winter wheat and corn also are grown.

The soils in this mapping unit are susceptible to soil blowing and water erosion if the surface is unprotected. Management is needed that provides stubble mulching, use of crop residue, and a suitable rotation that includes close-sown, high-residue crops, such as alfalfa and tame grasses. In places contour farming and terracing are needed to control water erosion. (Sandy range site; capability unit IVe–2; windbreak suitability group 1)

Hoven Series

This series consists of deep, nearly level soils that have a claypan. These soils occupy depressions on the uplands of the county. They formed in local alluvium that has washed down from adjacent slopes.

In a typical profile the surface layer is gray silt loam about 5 inches thick.

The subsoil is about 29 inches thick. To a depth of 17 inches, it is gray silty clay, and the rest is dark-gray silty clay loam. The silty clay is hard and very hard when dry and is firm to extremely firm when moist. The silty clay loam is hard and slightly hard when dry and is firm to friable when moist. The lower part of the subsoil is spotted and streaked with soft lime and salts.

The underlying material is gray and grayish brown in color and is silt loam and silty clay loam in texture. Spots and streaks of soft lime and of salts occur at a depth of 45 inches.

At a depth of 55 inches is light-gray, soft, bedded sandstone that is calcareous and contains thin strata of hard sandstone that is chipped readily with a spade.

Drainage is somewhat poor to poor in the Hoven soils. Because these soils have very slow permeability, they are ponded by runoff from adjacent slopes. Hoven soils have moderate fertility, but use for crops is limited by wetness in the spring and by poor tilth.

The native vegetation on Hoven soils is mainly mid grasses. Short grasses grow on some of the less frequently ponded areas, and small sedges grow in the wetter areas. Many of the smaller depressions in the central part of the county are cultivated, and winter wheat and alfalfa are the main crops. Crop growth is variable and depends on the frequency of ponding. Other areas are in native grasses and are used for grazing and hay.

Typical profile of Hoven silt loam in native grasses, 1,000 feet north and 700 feet west of the southeast corner, section 7, T. 37 N., R. 39 W.:

A1—0 to 2 inches, gray (10YR 5/1) silt loam, very dark brown (10YR 2/2) when moist; weak, fine, granular structure; soft, friable; neutral; clear, wavy boundary.

A2—2 to 5 inches, gray (10YR 6/1) silt loam, very dark gray (10YR 3/1) when moist; weak, thin, platy structure; soft, friable; neutral; abrupt, wavy boundary.

B21t—5 to 9 inches, gray (10YR 5/1) silty clay, very dark gray (10YR 3/1) when moist; weak, medium, columnar structure breaking to strong, medium, blocky structure; very hard, firm; tops and upper sides of columns are light gray (10TR 6/1); thin, distinct, continuous clay films; mildly alkaline; clear, wavy boundary.

B22t—9 to 17 inches, gray (10YR 5/1) silty clay, very dark gray (10YR 3/1) when moist; strong, medium and fine, blocky structure; extremely hard, very firm; thin, distinct clay films; few pressure faces oriented obliquely; mildly alkaline; clear, wavy boundary.

B23t—17 to 25 inches, dark-gray (10YR 4/1) silty clay loam, very dark gray (10YR 3/1) when moist; moderate, medium, blocky structure; hard, firm; thin continuous clay films; moderately alkaline; abrupt, wavy boundary.

B3casa—25 to 34 inches, dark-gray (10YR 4/1) silty clay loam, very dark gray (10YR 3/1) when moist; weak, medium, blocky and subangular blocky structure; slightly hard, friable; thin, patchy clay films on vertical faces; common, fine, distinct concretions of soft lime and salts; moderately alkaline; gradual boundary.

C1casa—34 to 40 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; massive; slightly hard, friable; common, fine, distinct concretions of soft lime and salts; moderately alkaline; abrupt boundary.

C2(A1b)—40 to 45 inches, gray (10YR 5/1) silt loam, very dark brown (10YR 2/2) when moist; massive; slightly hard, friable; moderately alkaline; abrupt boundary.

C3—45 to 55 inches, grayish-brown (2.5Y 5/2) silty clay loam, dark grayish brown (10YR 4/2) when moist; massive; hard, firm; moderately alkaline; abrupt boundary.

IIR—55 to 60 inches, light-gray (2.5Y 7/2) soft, bedded sandstone, grayish brown (2.5Y 5/2) when moist; thin strata of hard sandstone that is chipped readily by the spade; calcareous; moderately alkaline.

The A horizon ranges from 1 to 6 inches in thickness. In cultivated areas a gray crust about a quarter of an inch thick forms on the surface when it is dry. The silty clay part of the B horizon ranges from 12 to 30 inches in thickness, and the columnar structure in that part is weak to strong. Salts normally are visible in either the lower part of the B horizon or the upper part of the C horizon. In most places the C horizon is silty to a depth of 5 feet or more, but in some places there is an abrupt change to soft, bedded sandstone at a depth below 50 inches.

Hoven soils are grayer in the B horizon than Dawes soils and have a thinner surface layer than Dawes or Mosher soils. The Hoven soils are less saline than Minatare soils.

Hoven silt loam (0 to 1 percent slopes) (Hv).—This soil occupies flat-bottomed depressions in the uplands. It is in all parts of the county except the sandhills. Many of the areas are in the central and western parts. Areas are circular to oval in shape and generally are less than 20 acres in size. A few are more than 40 acres.

Most of the small areas are occupied mainly by a soil that has a profile similar to that described as typical for the Hoven series. In a few of the more shallow depressions, soils are included that resemble the Mosher soils and have a surface layer as much as 10 inches thick. One large depression north of the village of Swett has better surface drainage than the smaller depressions. Hoven silt loam is in the main basin of this depression, and soils similar to Dawes soils are on the outer rim.

More than half the acreage of this soil is cultivated. Winter wheat and alfalfa are the main crops. Although many of the smaller depressions are nuisance areas, some of them are farmed in most years; others are farmed around and are used for hay. Crop growth is poor or none in wet years but is good to excellent in dry years and in years when precipitation is average.

Seasonal wetness, poor tilth, and poor rooting of plants in the dense claypan are the main concerns of management.

Wetness in cropped areas can be reduced by controlling runoff on adjacent soils. Hoven silt loam should not be grazed when it is wet. (Closed Depression range site; capability unit VIs-1; windbreak suitability group not assigned)

Kadoka Series

This series consists of moderately deep to deep, gently sloping to moderately steep, silty soils that are scattered on the uplands in areas along the north county line. These soils formed in materials weathered from bedded silt and siltstone.

In a typical profile the surface layer is grayish-brown silt loam about 6 inches thick. The subsoil, about 12 inches thick, is silty clay loam that is hard when dry and firm when moist. It is dark brown in the upper part and light brown in the lower part. The underlying material is calcareous, white silt loam that contains a few fine fragments of siltstone. Just below, at a depth of about 30 inches, is pink, soft, bedded siltstone.

Kadoka soils are well drained. Surface runoff is medium, and permeability is moderate. These soils have moderate water-holding capacity and moderate natural fertility. They are easily worked.

The native vegetation on Kadoka soils is mid and short grasses. About half of the small acreage of these soils is cultivated, mainly to winter wheat and alfalfa. The remaining acreage is in native grasses and is used for grazing and hay.

Typical profile of Kadoka silt loam, 3 to 5 percent slopes, in cropland, 1,840 feet west and 120 feet south of the northeast corner, section 2, T. 39 N., R. 35 W.:

Ap—0 to 6 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft, friable; neutral; abrupt, smooth boundary.

B21t—6 to 11 inches, dark-brown (7.5YR 4/2) silty clay loam, dark brown (7.5YR 4/2) when moist; weak, fine and medium, prismatic structure breaking to moderate, medium and fine, subangular blocky structure; hard, firm; moderately thick, continuous clay films on all ped faces; mildly alkaline; clear, smooth boundary.

B22t—11 to 18 inches, light-brown (7.5YR 6/2) silty clay loam, brown (7.5YR 5/4) when moist; very weak, fine and medium, prismatic structure breaking to moderate, medium and fine, subangular blocky structure; hard, firm; moderately thick, continuous clay films on vertical ped faces and thin, patchy clay films on horizontal ped faces; moderately alkaline; abrupt, smooth boundary.

C1ca—18 to 30 inches, white (7.5YR 8/1) silt loam, pink (7.5YR 7/4) when moist; massive; hard, firm; calcareous; moderately alkaline; gradual boundary.

C2ca—30 to 60 inches, pink (7.5YR 8/4), soft, bedded siltstone; pink (7.5YR 7/4) when moist; common, angular fragments of hard, noncalcareous siltstone as much as 1

inch in diameter make up 5 percent of the mass; fine earth occurs, is calcareous, and contains a few medium accumulations of soft lime; moderately alkaline.

The Ap horizon ranges from 3 to 8 inches in thickness, and from dark gray to grayish brown in color. The B2t horizon ranges from 8 to 16 inches in thickness, has weak to moderate, prismatic and subangular blocky structure, and is friable to firm when moist. Depth to lime ranges from 12 to 24 inches. In some places a B3ca horizon occurs. The C1ca horizon ranges from white to pale brown in color. The C2ca horizon, or bedded siltstone, normally is at a depth of less than 40 inches.

Kadoka soils are deeper to siltstone than Epping soils and have a distinct B2t horizon, which the Epping soils do not have. They are more silty than Rosebud soils. Kadoka soils are not so deep as Keith soils and have harder underlying material.

Kadoka silt loam, 3 to 5 percent slopes (KaB).—This silty soil is on the uplands in three small areas along the north county line.

Included with this soil in mapping are small spots of Epping soils on the crest of the slopes. Also included are small areas of Goshen soils on small foot slopes along upland drains.

In Bennett County most of the small acreage of this Kadoka soil is cultivated, mainly to winter wheat and alfalfa. A small part is in native grass and is used for grazing and as hayland.

Control of water erosion is the main concern of management on this soil. Practices are needed that maintain content of organic matter and fertility so as to help control erosion, conserve moisture, and improve tilth. (Silty range site; capability unit IIe-1; windbreak suitability group 2)

Keith Series

In the Keith series are deep, nearly level to rolling, silty soils that formed in soft, silty materials. These soils occur on the uplands in all parts of the county except the sandhills.

In a typical profile the surface layer is dark-gray silt loam about 8 inches thick. The subsoil is about 19 inches thick. To a depth of about 16 inches, it is dark grayish-brown silty clay loam that is hard when dry and firm when moist. The rest is pale-brown silt loam that is slightly hard when dry and friable when moist. The calcareous underlying material is light-gray silt loam.

Keith soils are well drained. Surface runoff is medium, permeability is moderate, and water-holding capacity is high. These soils are moderate to high in natural fertility and are easy to work.

The native vegetation on Keith soils is mid and short grasses. More than 75 percent of the acreage of these soils is cultivated. Winter wheat, the main crop, grows especially well on these soils if summer fallow is used (fig. 7). Also grown are oats, barley, corn, sorghums, alfalfa, and tame grasses. Some areas are still in native grasses and are used for grazing and hay.

Typical profile of Keith silt loam, 0 to 3 percent slopes, in native grasses, 1,300 feet north and 800 feet east of the southwest corner, section 20, T. 38 N., R. 33 W.:

A11—0 to 3 inches, dark-gray (10YR 4/1) silt loam, very dark brown (10YR 2/2) when moist; weak, fine, granular structure; soft, very friable; neutral; abrupt, smooth boundary.

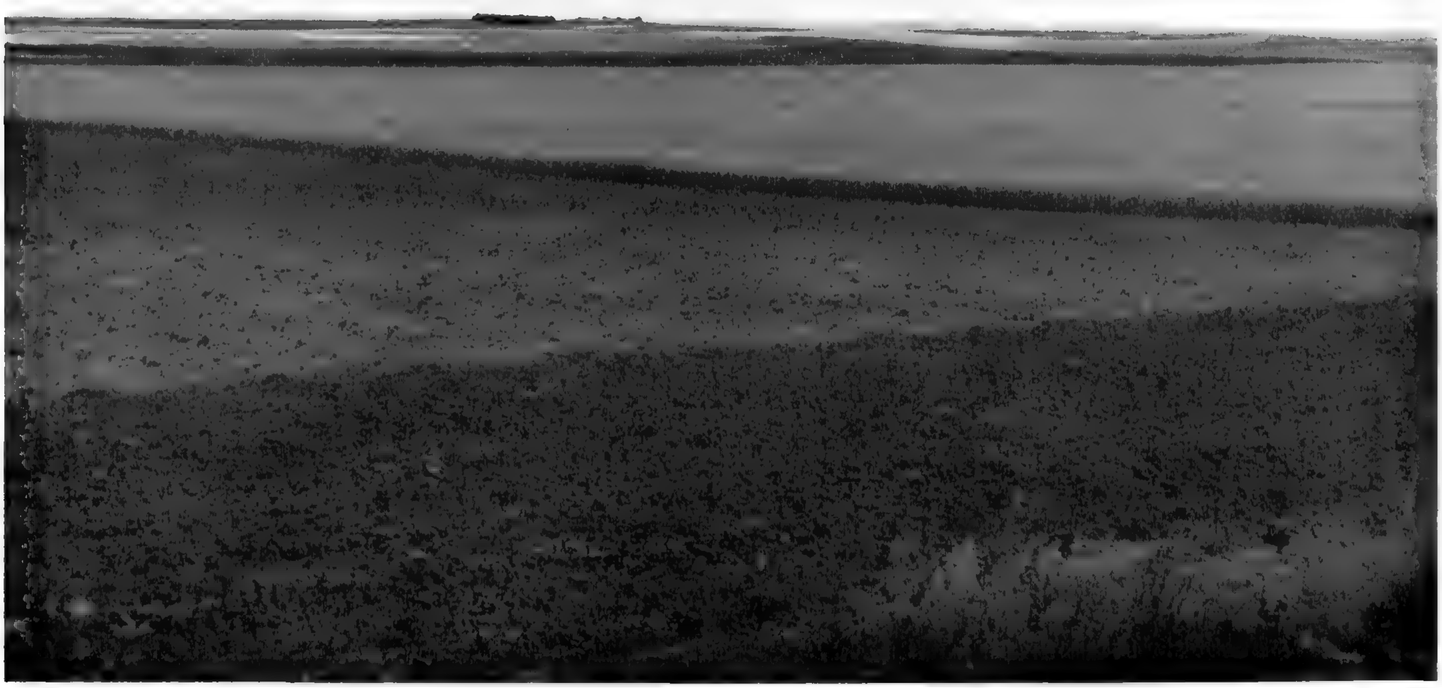

Figure 7.—**Winter wheat and summer fallow, a common cropping sequence on Keith soils.**

A12—3 to 8 inches, dark-gray (10YR 4/1) silt loam, very dark brown (10YR 2/2) when moist; weak, medium, subangular blocky structure breaking to weak, fine, granular structure; slightly hard, friable; neutral; abrupt, smooth boundary.

B2t—8 to 16 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, prismatic structure breaking to moderate, medium, blocky and subangular blocky structure; hard, firm; thin continuous clay films on ped faces; neutral; clear, smooth boundary.

B3—16 to 27 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 5/3) when moist; weak, medium and coarse, prismatic structure; slightly hard, friable; thin, patchy clay films on vertical ped faces; mildly alkaline; abrupt, wavy boundary.

C1ca—27 to 37 inches, light-gray (10YR 7/2) silt loam, brown (10YR 5/3) when moist; very weak, coarse, prismatic structure; soft, friable; calcareous; strongly alkaline; gradual boundary.

C2ca—37 to 52 inches, light-gray (10YR 7/2) silt loam, pale brown (10YR 6/3) when moist; massive; soft, very friable; calcareous with a few, fine, soft lime segregations; strongly alkaline; gradual boundary.

C3—52 to 60 inches, light-gray (10YR 7/2) silt loam, pale brown (10YR 6/3) when moist; massive; soft, very friable; calcareous; moderately alkaline.

The A horizon ranges from 4 to 10 inches in thickness, from dark gray to grayish brown in color, and from silt loam to loam in texture. The B horizon ranges from 12 to 40 inches in thickness and from dark grayish brown to pale brown in color. The B2t horizon ranges from silty clay loam to heavy silt loam. Lime begins at a depth of 16 to 32 inches, either in the lower part of the B horizon or in the C horizon. The C horizon is light gray to pale brown and in most places extends to a depth of 5 feet or more. In a few places in the underlying material, there is an abrupt change from silt loam to gravel at a depth below 40 inches. In some places the silty underlying material is abruptly underlain by weathered materials containing bits of sandstone or siltstone.

Keith soils have a thicker surface layer, have a more distinct subsoil, and are deeper to lime than Colby or Ulysses soils. The subsoil of Keith soils is less clayey than that of the Dawes or Richfield soils. Keith soils are deeper than Kadoka or Rosebud soils and have softer underlying materials. They are better drained than Goshen soils and have thinner dark-colored horizons.

Keith silt loam, 0 to 3 percent slopes (KeA).—This soil occupies stream terraces and uplands. It is scattered throughout most of the county except the sandhills. It has the profile described as typical for the series.

Included with this Keith soil in mapping are small areas of Dawes, Goshen, and Richfield soils. These included soils are in the more nearly level areas and generally are slightly depressional. They make up less than 10 percent of the mapping unit. Also included, adjacent to sandy soils, are areas of a Keith soil that has a loam surface layer.

Most areas of Keith silt loam, 0 to 3 percent slopes, are cultivated. Winter wheat, oats, barley, corn, and alfalfa are grown. Winter wheat grows well.

Conserving moisture is the main concern in the management of this soil. Controlling soil blowing is secondary. Management is needed that uses crop residues so as to help conserve moisture, control soil blowing, and maintain fertility and good tilth. (Silty range site; capability unit IIc–1; windbreak suitability group 2)

Keith silt loam, 3 to 5 percent slopes (KeB).—This soil is on uplands in all parts of the county except the sandhills. It has a profile similar to that described as typical for the series.

Included with this Keith soil in mapping are small areas of Goshen, Richfield, Rosebud, and Ulysses soils. The Ulysses soil occurs on the upper part of some slopes. The Rosebud soil is on the crest of low-lying ridges or is on the sharp shoulders along drainageways. The Richfield soil occurs on some of the lower slopes, and the Goshen soil is in swales. Also included in mapping are small areas of Keith soil on 5 to 9 percent slopes. These included soils make up less than 15 percent of the mapping unit.

Most areas of this soil are cultivated. Winter wheat, the main crop, grows well. Also grown are oats, barley, corn, and alfalfa. A few areas are still in native grasses and are used for grazing and hay.

On this soil the main concerns of management are water erosion and moisture insufficient for good growth of plants. Management is needed that maintains fertility, content of organic matter, and good tilth so as to help control water erosion and conserve moisture. (Silty range site; capability unit IIe 1; windbreak suitability group 2)

Keith-Colby silt loams, 9 to 12 percent slopes (KhD).—This complex consists of rolling soils on uplands, mainly in the northeastern and western parts of the county. Areas range from 20 to 100 acres in size. The Keith soil makes up 75 to 85 percent of the acreage mapped and the Colby soils, 15 to 25 percent.

The Keith soil occupies most of the side slopes and, in some places, has a thinner surface layer than that in the profile described as typical for the series. The Colby soil is on the tops of well-rounded ridges and knolls and the upper parts of their side slopes. The profile described as typical for the Colby series is from this complex.

Included with these Keith and Colby soils in mapping are small areas of a Ulysses soil that generally are below the Colby soil and above the Keith soil. This included soil makes up less than 10 percent of the mapping unit.

More than half the acreage of this complex is in native grasses and is used for grazing. Winter wheat and alfalfa are the main cultivated crops.

Erosion is the main concern in managing the soils in this complex. Intensive practices are needed to control erosion in cultivated areas. Proper range use helps to control erosion on rangeland. (The Keith soil is in the Silty range site, and the Colby soil is in the Thin Upland range site; both kinds of soils are in capability unit IVe–1 and windbreak suitability group 2)

Keith-Rosebud silt loams, 0 to 2 percent slopes (KrA).—This complex occupies upland divides, mainly in the central and western parts of the county. The Keith soil or the Rosebud soil each makes up 40 to 60 percent of the acreage mapped.

The Rosebud soil in this complex has a more silty surface layer than that described for the series. In places both Keith and Rosebud soils have a loam surface layer. Other inclusions are small areas of Goshen and of Hoven soils. The Goshen soil occurs along slightly depressional drainageways, and the Hoven soil occupies potholes or wet spots. These included soils make up less than 5 percent of the mapping unit.

Most areas of this complex are cropland. Winter wheat, the main crop, grows well on these soils. Also grown are oats, barley, corn, and alfalfa.

Conserving moisture is the main purpose of management on this complex. Control of soil blowing is secondary. The practices needed are those that use crop residues so as to conserve moisture and to help control soil blowing. (Silty range site; capability unit IIc–1; windbreak suitability group 2)

Keith-Rosebud silt loams, 2 to 6 percent slopes (KrB).—This complex is on the uplands, mainly in the central and western parts of the county. Most areas are more than 40 acres in size. Slopes are mostly less than 6 percent. The Keith soil or the Rosebud soil each makes up 30 to 60 percent of the acreage mapped, but in most places the Keith soil is dominant.

The Keith soil has the longer and smoother slopes on the landscape, and generally they face to the south and east. The slopes of the Rosebud soil are higher on the landscape and generally face to the north.

Included with these Keith and Rosebud soils in mapping are small areas of Canyon, Goshen, and Hoven soils. The Canyon soil is on the top of some ridges or is on the shoulders of upland drainageways. The Goshen soil is in swales that are the heads of drainageways. The Hoven soil occupies very small depressions. These included soils make up about 10 percent of the mapped acreage. Also included, south of U. S. Highway No. 18, are small areas of Keith loam and of Rosebud loam.

Most areas of this complex are cultivated. Winter wheat is the main crop (fig. 8), and also grown are oats, barley, corn, sorghums, and alfalfa. Areas still in native grasses are used for grazing and hay.

Water erosion is the main concern of management on these soils. On cropland management is needed that uses crop residues so as to help control erosion and conserve moisture. Proper range use controls erosion on grazed areas. (Silty range site; capability unit IIe–1; windbreak suitability group 2)

Keith and Ulysses silt loams, 5 to 9 percent slopes (KuC).—These soils are on uplands in the northern and western parts of the county. In some places the Keith soil is dominant, and in other places the Ulysses soil is dominant, but in a few places, the soils are in about equal parts.

The Keith soil has long, unbroken slopes. The slopes of the Ulysses soil are higher on the landscape and are convex. The Keith soil has a profile similar to the one described as typical for its series. The Ulysses soil has the profile described as typical for its series.

Included with these soils in mapping are small areas of a Colby soil on the tops of well-rounded knolls and ridges. Also included are small areas of Canyon, Goshen, Hoven, and Rosebud soils. These included soils make up less than 10 percent of the mapping unit.

About half of the acreage is still in native grasses and is used for grazing and hay. Winter wheat is the main crop in cultivated areas.

Control of water erosion is the main concern of management on this unit of soils. On the cropland, a combination of a suitable cropping sequence and suitable mechanical practices helps to control erosion. On range areas, only proper range use is needed. (Silty range site; capability unit IIIe–1; windbreak suitability group 2)

Figure 8.—**A field of winter wheat growing on Keith-Rosebud silt loams, 2 to 6 percent slopes.**

Lamo Series

This series consists of deep, nearly level, silty soils that have a water table at a moderate depth. These soils occupy basins and valleys on the edges of the sandhills and in the eastern part of the county.

In a typical profile the surface layer, about 14 inches thick, is dark-gray and gray silt loam that is black when moist. Just below is a transitional layer 7 inches thick. It is gray loam that is very dark gray when moist.

The underlying material extends to a depth of 62 inches and is stratified silt loam, clay loam, sandy clay loam, and loamy fine sand. A buried soil surface is included.

Lamo soils are poorly drained. The water table in them is near the surface early in the growing season and rarely drops below 4 feet by late in summer. Surface runoff is very slow, and permeability is moderate to moderately slow. These soils have high natural fertility, but their use is limited by the water table.

The native vegetation on Lamo soils is tall and mid grasses and water-loving sedges. Most areas are in native grasses and are used for grazing and hay. Forage plants grow well on these soils.

Typical profile of Lamo silt loam, in native grasses, 1,640 feet north and 100 feet west of the southeast corner, section 13, T. 36 N., R. 36 W.:

A11—0 to 6 inches, dark-gray (10YR 4/1) silt loam, black (10YR 2/1) when moist; moderate, fine, granular structure; soft, very friable; calcareous; moderately alkaline; clear, smooth boundary.

A12—6 to 14 inches, gray (10YR 5/1) silt loam, black (10YR 2/1) when moist; very weak, medium, subangular blocky structure breaking to weak, fine, granular structure; soft, friable; calcareous; moderately alkaline; clear, smooth boundary.

AC—14 to 21 inches, gray (10YR 5/1) loam, very dark gray (10YR 3/1) when moist; massive; friable, sticky; calcareous; moderately alkaline; clear, smooth boundary.

C1—21 to 31 inches, gray (5Y 6/1) silt loam, dark grayish brown (10YR 4/2) when moist; massive; friable, sticky; calcareous; moderately alkaline; abrupt, smooth boundary.

C2—31 to 36 inches, gray (10YR 6/1) clay loam, dark grayish brown (10YR 4/2) when moist; massive; friable, sticky; calcareous; moderately alkaline; abrupt boundary.

C3—36 to 52 inches, light brownish-gray (10YR 6/2) loamy fine sand, grayish brown (10YR 5/2) when moist; single grain; very friable, slightly sticky; calcareous; moderately alkaline; abrupt boundary.

A1b—52 to 62 inches, gray (10YR 5/1) sandy clay loam, dark gray (10YR 4/1) when moist; massive; sticky; mildly alkaline.

The A horizon ranges from 8 to 20 inches in thickness and from loam to silty clay loam in texture. The moderately dark colored AC horizon ranges from 6 to 18 inches in thickness. The C horizon is stratified. In most places sand or loamy fine sand occurs at a depth ranging from 20 to 60 inches. The dark-colored, buried A1b horizon commonly occurs, and it ranges from silty to clayey.

Lamo soils contain more silt and clay and are more calcareous than Loup soils. They lack the moderately fine textured B horizon of Mosher soils. The poorly drained Lamo soils are darker colored than the moderately well drained to well drained Haverson soils.

Lamo silt loam (0 to 2 percent slopes) (La).—This poorly drained soil occupies basins and valleys in the southern and eastern parts of the county. Areas are as much as 450 acres in size.

Included with this soil in mapping are small areas of Elsmere, Loup, and Mosher soils. Elsmere and Loup soils are on the edges of some areas adjacent to Valentine soils. Mosher soils are on the edges of some areas adjacent to Keith and Rosebud soils.

Nearly all the acreage of this soil is in native grasses and is used for grazing or hay. Tame grasses and red clover have been introduced into some areas. Forage plants grow well on this soil.

A high water table limits the use of this soil to hay and pasture. In most years the water table is near the surface early in the growing season, but by the middle of the summer it drops to a depth of about 3 feet or more and, thus, does not interfere with haying operations. Management is needed that maintains the cover of tall grasses on this soil. (Subirrigated range site; capability unit Vw-1; windbreak suitability group 3)

Loup Series

The Loup series consists of deep, nearly level, loamy soils that formed in sandy materials that have a fluctuating water table. These soils occupy basins and valleys in and near the sandhills of Bennett County.

In a typical profile the surface layer is about 11 inches thick. The upper part is very dark gray, calcareous fine sandy loam, and the lower part is dark-gray loam that is neutral. These soil materials are black when moist. Just below is a transitional layer that is gray loamy fine sand about 7 inches thick. It is loose when dry and is very dark gray and very friable when moist.

The underlying material extends to a depth of 60 inches. It consists of stratified fine sand, sandy loam, and fine sandy loam. The lower strata include layers of a buried soil.

Loup soils are poorly drained. The water table is at or near the surface for short periods in the spring, and in the summer rarely drops below a depth of 40 inches. Surface runoff is very slow. Permeability above the water table is moderately rapid. Loup soils are high in natural fertility, but the fluctuating water table makes cultivation impractical.

The native vegetation on Loup soils is tall and mid grasses and water-loving sedges. Nearly all areas are in native grasses, and many are used as hay meadow. The water table and high fertility of these soils favor good growth of forage plants.

Typical profile of Loup fine sandy loam in native grasses, 905 feet west and 800 feet north of the center of section 15, T. 36 N., R. 34 W.:

A11—0 to 4 inches, very dark gray (10YR 3/1) fine sandy loam, black (10YR 2/1) when moist; weak, fine, granular structure; soft, friable, slightly sticky; calcareous; moderately alkaline; abrupt, smooth boundary.

A12g—4 to 11 inches, dark-gray (N 4/0) loam, black (10YR 2/1) when moist; weak, coarse, platy structure breaking to weak, fine, subangular blocky structure; soft, friable, sticky; neutral; abrupt, wavy boundary.

ACg—11 to 18 inches, gray (N 5/0) loamy fine sand, very dark gray (10YR 3/1) when moist; single grain; loose, very friable, nonsticky; neutral; abrupt, wavy boundary.

C1—18 to 36 inches, light-gray (10YR 7/2) fine sand, grayish brown (10YR 5/2) when moist; single grain; loose; neutral; abrupt boundary.

A1b—36 to 44 inches, dark-gray (N 4/0) sandy loam, black (10YR 2/1) when moist; massive; friable, sticky; neutral; abrupt boundary.

ACb—44 to 50 inches, gray (5Y 5/1) fine sandy loam, very dark gray (5Y 3/1) when moist; massive; friable, sticky; neutral; gradual boundary.

C1bg—50 to 60 inches, light-gray (5Y 7/1) fine sand, dark gray (5Y 4/1) when moist; single grain; loose; neutral.

The A horizon ranges from 6 to 20 inches in thickness and from loamy sand to fine sandy loam in texture. The ACg horizon ranges from 6 to 12 inches in thickness and in places has a few, faint, reddish-brown mottles. The Loup soils generally are calcareous at or near the surface but are neutral below. These soils are moderately sandy to sandy and in some places have strata of loam.

Loup soils are more sandy and less calcareous than Lamo soils. They are more poorly drained and normally grayer than Elsmere soils. Loup soils are not so wet as Gannett soils and do not have a fibrous, peaty layer on the surface.

Loup fine sandy loam (0 to 2 percent slopes) (Lo).—This poorly drained soil occupies basins and valleys in and near the sandhills of the county. Areas are as much as 300 acres in size.

Included with this soil in mapping are areas of Dunday, Elsmere, Gannett, and Lamo soils. The Dunday and Elsmere soils are on the slightly raised, outer edges of the valleys. Small rings of Gannett soils encircle lakes and marshes where this soil is mapped in the sandhills. Small areas of the Lamo soils occur with this soil in the valleys outside of the sandhills. These included soils generally make up less than 10 percent of the mapping unit. Also included are areas of Loup soils that have a sandy loam to loamy sand surface layer.

Almost all areas of Loup fine sandy loam are in native grasses and are used for hay and grazing. Tame grasses and red clover have been seeded in some meadows. Forage plants have good growth on this soil.

The water table is within the rooting zone during the growing season. Early in the growing season, tillage generally is not feasible because the water table rises to within 2 feet of the surface. This soil blows easily where the plant cover is destroyed. (Subirrigated range site; capability unit Vw–1; windbreak suitability group 3)

Marsh

Marsh (0 to 2 percent slopes) (Ma) is land that is under shallow water during most of the growing season. The water is seldom deeper than 2 feet. In Bennett County, Marsh occurs along the banks of Lake Creek and in narrow rings around lakes in the adjacent sandhills. Most areas are natural marsh, but some were made artificially when dikes were constructed on LaCreek Migratory Waterfowl Refuge. Coarse aquatic plants grow in areas of Marsh, which are interspersed with small bodies of open water.

Marsh is used primarily as habitat for waterfowl, including wading birds, and for beaver, mink, and muskrat. Deer and other forms of wildlife frequent the margins of Marsh. (Capability unit VIIIw–1; Marsh is not assigned a range site or windbreak suitability group)

Minatare Series

The Minatare series consists of deep, nearly level, saline, loamy soils that have a fluctuating water table. These soils are in valleys and basins, where they formed in alluvium.

In a typical profile the surface layer is gray and about 4 inches thick. The upper part is loam, and the lower part is very fine sandy loam.

The subsoil extends to a depth of about 19 inches. It is calcareous and, from its top downward, consists of 3 inches of light brownish-gray sandy clay loam, 3 inches of light brownish-gray very fine sandy loam, and 9 inches of dark grayish-brown clay loam. The upper two layers have many streaks and spots of salts. The subsoil in Minatare soils is slightly hard to very hard when dry and is friable and firm when moist.

The underlying material is light-gray very fine sandy loam that is calcareous.

Minatare soils are poorly drained. The fluctuating water table is close to the surface for short periods in the spring and late in the summer drops to a depth of as much as 5 feet. Runoff is slow and permeability is very slow. These soils have poor tilth and low to moderate natural fertility.

The native vegetation on Minatare soils is tall, mid, and short grasses. Almost all areas are in native grasses and are used for grazing and hay. Almost pure stands of inland saltgrass grow in areas that are in poor range condition or that have been cultivated. These soils are not suitable for cultivation, because of salts, poor tilth, and wetness.

Typical profile of a Minatare loam in native grasses, 1,940 feet south and 600 feet east of the northwest corner, section 15, T. 36 N., R. 40 W.:

A1—0 to 2 inches, gray (10YR 5/1) loam, very dark gray (10YR 3/1) when moist; weak, fine, granular structure; soft, friable; neutral; abrupt, smooth boundary.

A2—2 to 4 inches, gray (10YR 6/1) very fine sandy loam, gray (10YR 5/1) when moist; weak, medium, platy structure; soft, very friable; mildly alkaline; abrupt, wavy boundary.

B2tsa—4 to 7 inches, light brownish-gray (10YR 6/2) sandy clay loam, grayish brown (10YR 5/2) when moist; moderate, medium, columnar structure; very hard, friable; thin, distinct but patchy clay films; calcareous; many, medium, distinct, salt segregations; very strongly alkaline; abrupt, smooth boundary.

A'2sa—7 to 10 inches, light brownish-gray (10YR 6/2) very fine sandy loam, dark grayish brown (10YR 4/2) when moist; moderate, medium, prismatic structure; slightly hard, friable; thin, patchy, clay films; calcareous; many, medium, distinct, salt segregations; very strongly alkaline; abrupt, smooth boundary.

B'2t—10 to 19 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; strong and moderate, coarse, prismatic structure breaking to moderate, medium, subangular blocky structure; very hard, firm; moderately thick, continuous, clay films; calcareous; very strongly alkaline; clear, smooth boundary.

C—19 to 60 inches, light-gray (10YR 7/2) very fine sandy loam, grayish brown (10YR 5/2) when moist; massive; soft, friable; calcareous; very strongly alkaline.

The A horizon ranges from 1 to 5 inches in thickness. The combined thickness of the B2tsa, A'2sa, and B'2t horizons ranges from 10 to 18 inches. The upper part normally is light colored, but in places it is dark colored. The B2tsa horizon ranges from sandy clay loam to clay. Two or more sequences are typical. In some places there is only one sequence of horizons. Spots and streaks of salts are visible at a depth of 3 to 10 inches. In places the C horizon is stratified and is mottled with brown or reddish brown.

Minatare soils have a thinner surface layer than that in Mosher soils, have visible salts nearer the surface, and are more poorly drained.

Minatare soils (0 to 2 percent slopes) (Me).—These soils are on flats and valleys along the Little White River and its tributaries. Most areas are narrow and irregularly shaped, but some of the flats are about one-half mile in width. Areas are as much as 600 acres in size. In most places these soils have a profile similar to the one described as typical for the Minatare series, but in some places the texture of the surface layer is very fine sandy loam or silt loam.

Included with these soils in mapping are small, depressional spots in which water ponds at times. These spots have a gray crust on the surface. Beneath the crust is blocky to massive clay loam or clay that is streaked and spotted with salts to a depth of 6 inches. Little or no vegetation grows in these spots. Also included are small areas of Lamo, Loup, and Mosher soils. The Mosher soils are the most common. Included soils make up about 20 percent of the mapping unit.

Because Minatare soils are seasonally wet and have a high content of salt, they are not suitable for cultivation. All areas are used for grazing and hay. The water table contributes to the growth of forage where the grass cover is good to excellent. Where the grasses are in poor condition, the vegetation is almost entirely inland saltgrass. (Saline Lowland range site; capability unit VIs–1; windbreak suitability group 5)

Mosher Series

The Mosher series consists of deep, nearly level soils that have a claypan. These soils occupy basins and valleys, where they formed in silty to loamy alluvium. The water table is at a depth of 3 to 7 feet.

In a typical profile the surface layer is about 8 inches thick. It is grayish-brown silt loam in the upper 5 inches and gray silt loam in the lower part.

The subsoil is about 25 inches thick. The upper 8 inches is dark-gray clay loam that is very hard when dry, very firm when moist, and sticky and plastic when wet. The lower part is light brownish-gray silty clay loam. It is very hard when dry, is friable when moist, and has spots and streaks of salts.

The underlying material, to a depth of 55 inches, is white, calcareous silty clay loam that has fine streaks and spots of soft lime. Below this is a light-gray, mildly alkaline loamy fine sand.

Mosher soils are somewhat poorly drained. Surface runoff is slow, and permeability is very slow. During most of the year, the fluctuating water table is at a depth of 3 to 7 feet, but in some years, it rises to within 2 feet of the surface during short periods in spring. Mosher soils have moderate natural fertility, but crop growth is limited by the claypan in the subsoil, the high content of salts, and occasional wetness.

The native vegetation on Mosher soils is mainly mid and short grasses. Most areas are in native grasses and are used for grazing and hay. Some areas are cropland, and alfalfa is the main crop. Large amounts of alfalfa seed are harvested from the alfalfa fields on these soils.

Typical profile of a Mosher silt loam in native grasses, 2,585 feet north and 405 feet east of the southwest corner, section 23, T. 37 N., R. 35 W.:

A1—0 to 5 inches, grayish-brown (10YR 5/2) silt loam, very dark gray (10YR 3/1) when moist; weak, medium and fine, granular structure; slightly hard, very friable; neutral; clear, smooth boundary.

A2—5 to 8 inches, gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) when moist; very weak, medium, prismatic structure breaking to weak, medium and fine, granular structure; slightly hard, very friable; neutral; abrupt, wavy boundary.

B21t—8 to 11 inches, dark-gray (10YR 4/1) clay loam, black (10YR 2/1) when moist; moderate, coarse and medium, columnar structure; extremely hard, very firm, sticky and plastic; continuous clay films on peds; columns coated with light-gray (10YR 6/1) dust on tops and upper part of sides; moderately alkaline; clear, wavy boundary.

B22t—11 to 16 inches, dark-gray (10YR 4/1) clay loam, very dark brown (10YR 2/2) when moist; weak, medium, prismatic structure breaking to moderate, medium and fine, blocky structure; very hard, firm, sticky and plastic; continuous clay films on peds; moderately alkaline; gradual, wavy boundary.

B3sa—16 to 33 inches, light brownish-gray (10YR 6/2) silty clay loam, very dark grayish brown (2.5Y 3/2) when moist; moderate, medium, blocky and subangular blocky structure; very hard, friable, sticky and plastic; fine segregations and threads of salt that are common in upper part but are few in lower part; strongly alkaline; clear, irregular boundary.

C1casa—33 to 55 inches, white (10YR 8/1) silty clay loam, light gray (10YR 7/2) when moist; very weak, coarse and medium, subangular blocky structure; hard, friable, sticky and plastic; few, fine, faint, light olive-brown (2.5Y 5/4) mottles; calcareous; common, fine, white segregations of a carbonate; very strongly alkaline; gradual, wavy boundary.

IIC2—55 to 60 inches, light-gray (2.5Y 7/2) loamy fine sand, grayish brown (2.5Y 5/2) when moist; massive; soft, very friable; moderately alkaline.

The A horizon ranges from 4 to 9 inches in thickness and from dark gray to grayish brown in color. It is silt loam and loam. The B horizon ranges from 15 to 36 inches in thickness, has moderate to strong columnar and blocky structure and, in the upper part, is clay loam to clay that has clay content of 35 to 50 percent. Visible spots and streaks of salts generally are in the lower part of the B horizon, which is calcareous in places. The underlying sandy to clayey alluvium normally has layers of contrasting texture, and in places, there is an abrupt change to loamy material that contains gritty small fragments of sandstone.

Mosher soils are darker colored and have a thicker solum than Minatare soils. Also, Mosher soils have salts deeper in the profile. They are better drained than Minatare soils. Mosher soils are more poorly drained, are grayer, and contain more salts than Dawes soils, which have a somewhat thicker A horizon.

Mosher-Minatare complex (0 to 6 percent slopes) (Mm).—This complex occupies valleys and basins out of the sandhills in the eastern and southern parts of the county. Areas of this complex range from a few acres to as much as 1,000 acres in size. The Mosher soils make up about 70 percent of the complex, and the Minatare soils, about 30 percent. Each kind of soil has a profile similar to the one described as typical for its respective series.

In some places the Minatare soils are in depressions 6 to 12 inches below the level of the Mosher soils. These depressions are as much as 25 feet in diameter. Included with the Mosher and Minatare soils in mapping are small areas of Lamo soils.

The Mosher part of the complex has a moderately thick, friable surface layer that is easy to work, but the claypan subsoil limits penetration and development of plant roots. The Minatare part of the complex is too wet and saline

for use as cropland. Grazing and hay probably are the most practical uses for the soils in this complex.

Many areas of this complex are in native grasses and are used for grazing and hay. Alfalfa is the main crop in cultivated areas. The alfalfa stands have an uneven appearance because of the presence of Minatare soil. Alfalfa hay has poor to good growth on this complex, but a large amount of alfalfa seed is harvested in some years. (Mosher soils are in the Claypan range site, capability unit IVs-1, and windbreak suitability group 4; Minatare soils are in the Saline Lowland range site, capability unit VIs 1, and windbreak suitability group 5)

Oglala Series

This series consists of deep, nearly level to rolling, loamy soils on uplands in the central and northern parts of the county. These soils formed in loamy to silty materials over soft, fine-grained sandstone.

In a typical profile the surface layer is grayish-brown loam about 15 inches thick. Just below is a transitional layer of light brownish-gray loam about 10 inches thick. It is slightly hard when dry and very friable when moist. The underlying material is light-gray silt loam. It is soft when dry, very friable when moist, and calcareous at a depth of 32 inches. White, soft, fine-grained sandstone occurs at a depth of 42 inches.

Oglala soils are well drained. Surface runoff is medium to rapid, and permeability is moderate. Fertility and water-holding capacity are moderate. These soils are subject to both soil blowing and water erosion.

The native vegetation on Oglala soils is mid and short grasses. Most areas are in native grasses and are used for grazing and hay. Some areas are cultivated, and winter wheat, oats, barley, and alfalfa are the main crops.

Typical profile of an Oglala loam in native grasses, 2,430 feet north and 85 feet west of the southeast corner, section 21, T. 38 N., R. 37 W.:

A11—0 to 8 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, subangular blocky structure breaking to weak, fine, granular structure; slightly hard, friable; neutral; gradual, wavy boundary.

A12—8 to 15 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse and medium, prismatic structure breaking to weak, medium, subangular blocky structure; slightly hard, friable; mildly alkaline; clear, wavy boundary.

AC—15 to 25 inches, light brownish-gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) when moist; very weak, coarse, prismatic structure breaking to very weak, medium and fine, subangular blocky structure; slightly hard, very friable; mildly alkaline; gradual, wavy boundary.

C1—25 to 32 inches, light-gray (10YR 7/2) silt loam, brown (10YR 5/3) when moist; very weak, coarse and medium, subangular blocky structure to massive; soft, very friable; mildly alkaline; clear, wavy boundary.

C2—32 to 42 inches, light-gray (10YR 7/2) silt loam, brown (10YR 5/3) when moist; massive; soft, very friable; calcareous; a few faint threads of lime; moderately alkaline; clear, wavy boundary.

C3—42 to 60 inches, white (10YR 8/2) soft, fine-grained sandstone, light brownish gray (10YR 6/2) when moist; calcareous; moderately alkaline.

The A horizon ranges from 7 to 20 inches in thickness and from dark gray to grayish brown in color. It is loam and silt loam. The AC horizon ranges from 6 to 24 inches in thickness, is intermediate between the A horizon and the C horizon in color, and has very weak to weak structure. The texture of the AC horizon ranges from silt loam to loamy very fine sand. Depth to lime ranges from 25 to 50 inches. The soft, fine-grained sandstone normally is at a depth of about 42 inches, but in places it is below a depth of 5 feet.

Oglala soils are deeper than Canyon soils. They lack the B horizon that occurs in Keith and Rosebud soils. Oglala soils are less silty and are deeper to lime than Ulysses soils and are less sandy than Anselmo soils.

Oglala-Canyon complex, 9 to 18 percent slopes (OcE).—This complex occupies rolling uplands, mainly in the northern half of the county. Areas generally are more than 100 acres in size, and some areas are as much as 1,000 acres. Oglala soils make up 45 to 60 percent of the acreage mapped; Canyon soils, 20 to 35 percent; and other soils, about 20 percent.

Oglala soils occupy the mid slopes and lower slopes that are plane to concave in shape. Canyon soils are on ridgetops and convex upper parts of slopes. Each kind of soil has a profile similar to the one described as typical for its respective series.

Included with these soils in mapping are areas of Goshen and of Rosebud soils, which are the most common inclusions in the complex. The Goshen soils are on foot slopes and in round-bottom swales. The Rosebud soils are on the wider ridgetops and in places are on side slopes between the Canyon soils above and the Oglala soils farther downslope. Also included in mapping are small areas of Colby, Keith, and Ulysses soils. These inclusions occur in patches on well-rounded ridges and knolls and on some east- and south-facing slopes.

Almost all areas of this complex are in native grasses and are used mainly for grazing. A few small tracts, mostly of the Oglala soils, are cultivated or have been seeded to tame grasses. Where properly managed the Oglala soils generally are suitable for cultivation, but cultivation is impractical in most areas of this complex because of the erosion hazard and the presence of the Canyon soils. The Canyon soils are shallow, low in fertility, and somewhat excessively drained.

Range areas can be restored to good condition through grass seeding and other mechanical practices. Erosion is best controlled through proper range use. (The Oglala soils are in the Silty range site, capability unit VIe-1, and windbreak suitability group 2; the Canyon soils are in the Shallow range site and capability unit VIs-2, but a windbreak suitability group is not assigned)

Oglala-Rosebud silt loams, 0 to 3 percent slopes (OrA).—This complex is on uplands in the west-central part of the county, mainly to the south and southwest of Swett. Areas normally are more than 40 acres in size. The Oglala soil makes up about 65 percent of the mapped acreage; the Rosebud soil, 20 percent; and other included soils, about 15 percent.

The Oglala soil is on the long slopes, and the Rosebud soil occurs on slight rises in tablelike areas. In many places the Oglala soil has thin bands of rounded, lime-coated pebbles at a depth below 20 inches, but in most places it is free of lime to a depth below 30 inches.

Included in some mapped areas are small tracts of Goshen and of Keith soils. The Keith soil occurs at random. The Goshen soil is in slightly depressional areas along poorly defined drainageways. Also included

are areas of an Oglala soil and of a Rosebud soil that have a loam surface layer.

Nearly all areas of this complex are cultivated. Winter wheat is the main crop, but oats, barley, corn, and alfalfa also are grown. Growth of crops is good to excellent.

Conserving moisture for plant use is the main concern in management on this complex. Some of the broader areas are subject to soil blowing. Management is needed that makes good use of crop residues so as to help conserve moisture and control soil blowing where necessary. (Silty range site; capability unit IIc-1; windbreak suitability group 2)

Oglala-Rosebud silt loams, 3 to 6 percent slopes (OrB).—This complex is on uplands near Swett in the west-central part of the county. Areas range from 20 to 200 acres in size. The Oglala soil makes up about 50 percent of the acreage mapped; the Rosebud soil, 30 percent; and other included soils, about 20 percent.

The Oglala soil occupies most of the side slopes. The Rosebud soil is on the upper parts of slopes.

Included in most areas are small tracts of Canyon, Keith, and Ulysses soils. The Canyon soil is on top of some of the low-lying ridges and knolls. Keith and Ulysses soils are on some of the smooth slopes. Also included are areas of Oglala and of Rosebud soils that have a loam to fine sandy loam surface layer.

Most areas of this complex are cropland. Winter wheat is the main crop, but oats, barley, corn, and alfalfa also are grown.

The main concern of management on these soils is erosion because, in most areas, the soils wash and blow where the surface is unprotected. Management is needed that makes good use of crop residues to control erosion. (Silty range site; capability unit IIe-1; windbreak suitability group 2)

Richfield Series

This series consists of deep, nearly level to sloping, silty soils that have a firm, clayey subsoil. These soils formed in silty materials on the uplands.

In a typical profile, the surface layer is dark-gray and gray silt loam about 9 inches thick.

The subsoil is about 27 inches thick. From its top downward, it consists of 3 inches of grayish-brown silty clay loam that is hard when dry and friable when moist; 12 inches of clay loam that is grayish brown and light brownish gray in color, is hard and slightly hard when dry, and is friable to firm when moist; and 12 inches of light brownish-gray, calcareous silt loam that is soft to hard when dry, is friable when moist, and has fine, white spots and streaks of soft lime.

The underlying material also is light brownish-gray, calcareous silt loam, but it is soft when dry, is very friable when moist, and below a depth of 48 inches, contains a few fine fragments of sandstone.

Richfield soils are well drained. Surface runoff is slow to medium, and permeability is moderately slow. The water-holding capacity and natural fertility are high. The surface layer has good tilth and is easy to work.

The native vegetation on Richfield soils consists of mid and short grasses. A few areas are in native grasses and are used for grazing and hay. About 75 percent of the acreage of Richfield soils is cultivated, and winter wheat is the main crop.

Typical profile of a Richfield silt loam in a cultivated field, 2,110 feet east and 385 feet south of the northwest corner, section 12, T. 36 N., R. 37 W. (Laboratory No. 8923-8931):

Ap—0 to 7 inches, dark-gray (10YR 4/1) silt loam, black, (10YR 2/1) when moist; weak, fine, granular structure; soft, friable; slightly acid; abrupt, smooth boundary.

A12—7 to 9 inches, gray (2.5Y 5/1) heavy silt loam, black (2.5Y 2/1) when moist; weak, medium and fine, prismatic structure breaking to weak, medium, subangular blocky structure; slightly hard, friable; neutral; gradual, smooth boundary.

B21t—9 to 12 inches, grayish-brown (2.5Y 5/2) silty clay loam, very dark grayish brown (2.5Y 3/2) when moist; weak, medium and fine, prismatic structure breaking to weak, medium, subangular blocky structure; slightly hard, friable; gray (2.5Y 5/1) ped coats, very dark gray (2.5Y 3/1) when moist; neutral; gradual, smooth boundary.

B22t—12 to 18 inches, grayish-brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) when moist; moderate, medium, prismatic structure breaking to strong, medium and fine, blocky and subangular blocky structure; hard, firm; continuous gray (2.5Y 5/1) ped coats, dark gray (2.5Y 4/1) when moist; thin, distinct, continuous clay films; neutral; gradual, smooth boundary.

B23t—18 to 24 inches, light brownish-gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) when moist; moderate, medium and coarse, prismatic structure breaking to moderate, medium and fine, blocky and subangular blocky structure; hard, firm; thin, continuous clay films; mildly alkaline; clear, smooth boundary.

B31ca—24 to 30 inches, light brownish-gray (2.5Y 6/2) silt loam, grayish brown (2.5Y 5/2) when moist; weak, coarse, prismatic structure breaking to weak, coarse and medium, subangular blocky structure; slightly hard, friable; thin, very patchy clay films on vertical faces of prisms; calcareous; few, fine, distinct, soft lime segregations; moderately alkaline; gradual, smooth boundary.

B32ca—30 to 36 inches, light brownish-gray (2.5Y 6/2) silt loam, grayish brown (2.5Y 5/2) when moist; weak, very coarse, prismatic structure; soft, friable; thin, very patchy clay films on vertical ped faces; calcareous; common, fine, distinct segregations of soft lime; moderately alkaline; clear, smooth boundary.

Cca—36 to 48 inches, light brownish-gray (2.5Y 6/2) silt loam, grayish brown (2.5Y 5/2) when moist; massive; soft, very friable; calcareous; few, fine, distinct segregations of soft lime; moderately alkaline; gradual, smooth boundary.

C&R—48 to 68 inches, light brownish-gray (2.5Y 6/2) silt loam, light olive brown (2.5Y 5/3) when moist; massive; soft, very friable; common gritty bits and fragments of fine-grained sandstone; calcareous; few, fine, distinct segregations of soft lime; moderately alkaline.

The A horizon ranges from 4 to 14 inches in thickness and from dark gray to grayish brown in color. The B horizon ranges from 12 to 30 inches in thickness. The B2t horizon ranges from clay loam to silty clay in texture. Lime occurs at a depth ranging from 16 to 40 inches. The material in the C horizon normally is silty to a depth below 5 feet, but in places, at a depth of 40 inches or more, this material is loamy or silty and contains fragments of sandstone.

Richfield soils have a more clayey subsoil than Keith soils. They have a thinner, lighter and more brownish colored subsoil than that in the Goshen soils. Richfield soils lack the distinct, gray A2 horizon that occurs in the Dawes soils.

Richfield and Keith silt loams, 0 to 2 percent slopes (RkA).—These soils are deep and dark colored. They occur on tablelands in the central part of the county, mostly in areas as much as 800 acres in size. Some areas are mostly Richfield soil, some are mostly Keith soil, and many areas have a significant amount of both soils.

The Richfield soil occupies the more nearly level areas and is dominant on tablelands to the south and southeast of Martin. The Keith soil is on slight rises that have slopes of 1 to 2 percent. In most areas each kind of soil has a profile similar to the one described as typical for its respective series. In some places in the northern part of the county, the surface layer in each kind of soil is only 4 inches thick.

Included in some mapped areas are small tracts of Dawes, Goshen, and Hoven soils. Dawes and Goshen soils are on slightly concave slopes that form the heads of drainageways. Hoven soils are on small, wet depressional spots. These included soils make up less than 10 percent of the acreage mapped.

Most areas of this unit are cultivated. Winter wheat, the main crop, grows well on these soils. Also grown are oats, barely, corn, and alfalfa (fig. 9).

Conservation of moisture for plant use is the main concern in management of this unit. Erosion generally is not a concern, although some soil blowing occurs on mismanaged fields. Management is needed that uses crop residues to help conserve moisture, control erosion, and maintain good tilth. (Silty range site; capability unit IIc–1; windbreak suitability group 2)

Richfield and Keith silt loams, 2 to 6 percent slopes (RkB).—These soils are scattered on uplands throughout the county but do not occur in the sandhills. Most areas are more than 40 acres in size, and a few are as much as 700 acres. The proportion of each soil in the mapped areas varies from place to place. The Richfield soil makes up about 50 percent or more of some mapped areas, and other mapped areas are almost entirely made up of the Keith soil.

The Richfield soil is on the lower and mid parts of the longer slopes. The Keith soil normally is on the more convex, upper parts of the slopes. In some places, especially in the northern part of the county, the silt loam surface layer in these soils is only about 4 inches thick. In most places, however, each soil has a profile similar to the one described as typical for its respective series.

Included in mapping in some areas are small tracts of the Canyon, Colby, Dawes, Goshen, Hoven, Rosebud, and Ulysses soils. The tracts of Colby and Ulysses soils are on some of the more rounded knolls and ridges. Canyon and Rosebud soils are on the upper parts of some north-facing slopes. Dawes and Goshen soils are on foot slopes and in swales. Hoven soils are in small depressions. These included soils make up about 15 percent of the acreage mapped.

More than half the acreage of this mapping unit is cultivated. Winter wheat, the main crop, grows well. Also grown are oats, barley, corn, and alfalfa.

Control of erosion and conservation of moisture for plant use are the main concerns in management on the soils in this unit. They are susceptible to water erosion during summer fallow and, if they are not adequately protected by vegetation during winter, to soil blowing. In most areas management is needed that uses crop residues to help control erosion on fields where content of organic matter has decreased and where structure and tilth have deteriorated. (Silty range site; capability unit IIe–1; windbreak suitability group 2)

Rosebud Series

In the Rosebud series are moderately deep, nearly level to rolling, loamy soils on uplands in the central and northern parts of the county. These soils formed in loamy to

Figure 9.—Alfalfa stubble on Richfield and Keith silt loams, 0 to 2 percent slopes.

371-550—71——3

silty materials that are over soft to partly consolidated sandstone at moderate depths.

In a typical profile the surface layer, about 8 inches thick, is gray loam in the upper part and dark-gray loam in the lower part. The subsoil, about 7 inches thick, is gray loam that is slightly hard when dry and friable when moist. The underlying material is white, calcareous loam that contains many fragments of hard sandstone. At a depth of about 28 inches this material is underlain by calcareous, bedded soft sandstone that crushes to very fine sandy loam.

Rosebud soils are well drained. Surface runoff is medium, and permeability is moderate. These soils have moderate natural fertility, have good tilth, and are easy to work. Sloping areas are susceptible to water erosion.

The native vegetation on Rosebud soils consists of mid and short grasses. In the northern part of the county, sloping areas are mostly in native grasses and are used for grazing and hay. In the central part, more than half the acreage is cropland. Winter wheat is the main crop, and also grown are oats, barley, corn, alfalfa, and tame grasses.

In Bennett County, Rosebud soils are mapped only in complexes with Canyon soils, with Keith soils, and with Oglala soils.

Typical profile of a Rosebud loam in native grasses, 2,340 feet west and 800 feet north of the southeast corner, section 7, T. 36 N., R. 40 W.:

A11—0 to 4 inches, gray (10YR 5/1) loam, very dark gray (10YR 3/1) when moist; weak, fine, granular structure; soft, friable; mildly alkaline; clear, smooth boundary.

A12—4 to 8 inches, dark-gray (10YR 4/1) loam, very dark gray (10YR 3/1) when moist; very weak, coarse, prismatic structure breaking to weak, fine and medium, subangular blocky structure; slightly hard, friable; mildly alkaline; clear, wavy boundary.

B2t—8 to 15 inches, gray (10YR 5/1) heavy loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium and coarse, prismatic structure breaking to weak, medium, subangular blocky structure; slightly hard, friable; thin patchy clay films; few, fine, gritty fragments of hard sandstone; mildly alkaline; gradual, wavy boundary.

C1ca—15 to 28 inches, white (10YR 8/2) loam, light gray (10YR 7/2) when moist; massive; slightly hard, friable; many fragments of hard sandstone make up about 10 percent of mass; calcareous; moderately alkaline; gradual boundary.

C2—28 to 45 inches, white (10YR 8/2) soft, bedded sandstone, light gray (10YR 7/2) when moist; few fragments of more resistant sandstone; calcareous; moderately alkaline.

The A horizon ranges from 4 to 9 inches in thickness; ranges from dark gray to grayish brown in color; and is loam, very fine sandy loam, and silt loam in texture. The B horizon ranges from 6 to 20 inches in thickness and from heavy loam to clay loam in texture. In places the upper part of the B horizon is silty clay loam. Depth to lime ranges from 12 to 26 inches, and the lime occurs either in the lower part of the B horizon or in the C horizon. The C2 horizon ranges from white to very pale brown, and in some places there is a layer of more resistant, moderately cemented sandstone.

The Rosebud soils are darker colored and deeper than Canyon soils and have a distinct B horizon. They have a more clayey subsoil than Oglala soils and are calcareous nearer the surface. The Rosebud soils are less silty than the Kadoka or Keith soils.

Tassel Series

The Tassel series consists of rolling to hilly, loamy, calcareous soils that are shallow over sandstone. These soils are on uplands, mainly in the eastern part of the county.

In a typical profile the surface layer is gray to grayish-brown fine sandy loam about 3 inches thick. The next layer is transitional and consists of light brownish-gray, loose loamy fine sand about 4 inches thick. It is calcareous and contains fragments of sandstone. The underlying material is light-gray, calcareous loamy fine sand that has many fragments of sandstone. Bedded sandstone underlies this material at a depth of 11 inches.

Tassel soils are somewhat excessively drained. Surface runoff is slow to medium, and permeability is moderately rapid. Water-holding capacity and natural fertility are low. These soils are highly susceptible to water erosion and soil blowing where there is not enough plant cover for protection.

The native vegetation on Tassel soils consists mainly of mid and short grasses, but tall grasses grow in smaller amounts. All areas of these soils are in native grasses and are used for grazing.

In this county Tassel soils are mapped only in complexes with Anselmo soils and with Valentine soils.

Typical profile of Tassel fine sandy loam, 18 to 40 percent slopes, in native grasses, 1,340 feet south and 790 feet west of the northeast corner, section 5, T. 37 N., R. 33 W.:

A11—0 to 1 inch, gray (10YR 5/1) fine sandy loam, very dark gray (10YR 3.1) when moist; weak, fine, granular structure; soft, very friable; few fine bits of calcareous sandstone; mildly alkaline; abrupt, wavy boundary.

A12—1 to 3 inches, grayish-brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft, very friable; few fine bits of calcareous sandstone; mildly alkaline; abrupt, smooth boundary.

AC—3 to 7 inches, light brownish-gray (10YR 6/2) loamy fine sand, dark grayish brown (10YR 4/2) when moist; single grain; soft, very friable; common, small fragments of hard, calcareous sandstone; calcareous; moderately alkaline; clear, wavy boundary.

C1—7 to 11 inches, light-gray (10YR 7/2) loamy fine sand, brown (10YR 5/3) when moist; single grain; loose; many fragments of hard, calcareous sandstone up to 3 inches in diameter; calcareous; moderately alkaline; clear, wavy boundary.

C2—11 to 60 inches, light-gray (2.5Y 7/2), soft, bedded sandstone, grayish brown (2.5Y 5/2) when moist; contains pipy concretions of white (10YR 8/1), hard sandstone; sandstone concretions light brownish gray (10YR 6/2) when moist; calcareous; moderately alkaline.

The AC horizon is not present in some places. In places where it is not present, the A horizon ranges from 1 to 6 inches in thickness and from dark gray to light brownish gray in color. In some places the AC horizon has weak prismatic or subangular blocky structure and ranges from loamy sand to fine sandy loam in texture. These soils generally are calcareous at a depth within 6 inches of the surface. Depth to bedded sandstone ranges from 6 to 20 inches.

Tassel soils are lighter colored and more shallow than Holt soils and lack a B horizon. They are more sandy than the Canyon or Epping soils.

Tassel-Anselmo complex, 18 to 40 percent slopes (TaF).—This complex of hilly soils is on uplands in the northeastern part of the county. It occupies steep sandstone ridges and side slopes of ravines (fig. 10). Mapped areas generally are more than 40 acres in size, and some

Figure 10.—**Tassel-Anselmo complex, 18 to 40 percent slopes.**

are as much as 700 acres. Tassel soils make up 70 to 85 percent of the complex, and Anselmo soils, 15 to 30 percent.

Tassel soils are on ridges and the steeper side slopes. In places sandstone crops out in small spots. Anselmo soils are on the less steep, lower parts of slopes that normally are of less than 20 percent. The Tassel soil has the profile described as typical for the Tassel series. Except that the Anselmo soils in places contain small fragments of sandstone, they have a profile similar to the one described as typical for the Anselmo series.

Included with the Tassel and Anselmo soils in some mapped areas are small tracts of Holt, Valentine, and Vetal soils. Holt soils are on some of the nearly level ridgetops. Vetal soils are on concave foot slopes. Valentine soils are on leeward slopes where wind has modified sandy material eroded from the more exposed areas of sandstone outcrops. These included soils make up less than 15 percent of the acreage mapped, though they are absent in some mapped areas.

All of the complex is in native grasses and is used for grazing. Pine trees are scattered on some north-facing slopes. This complex is susceptible to water erosion and soil blowing in places where plant cover is inadequate for protection. Proper range use helps control erosion. Seeding and other mechanical practices are feasible only on the Anselmo parts of the complex. (The Tassel soils are in the Shallow range site and capability unit VIIs-1 but are not assigned a windbreak suitability group; the Anselmo soils are in the Sandy range site, capability unit VIe-1, and windbreak suitability group 1)

Tuthill Series

The Tuthill series consists of deep, nearly level and undulating, loamy soils. These soils occupy uplands in the eastern part of the county. They formed in loamy to sandy materials.

In a typical profile the surface layer is dark grayish-brown fine sandy loam about 9 inches thick. The subsoil is about 20 inches thick. The upper 15 inches is light brownish-gray sandy clay loam and clay loam that is hard when dry and firm when moist. The lower 5 inches is light brownish-gray loam that is hard when dry and friable when moist. The underlying material is light-gray to white loamy sand that is calcareous below a depth of 48 inches.

Tuthill soils are well drained. Runoff is slow to medium, and permeability is moderate. These soils have moderate to high water-holding capacity and moderate natural fertility. They are susceptible to soil blowing and water erosion.

The native vegetation on Tuthill soils consists mainly of mid and short grasses, but some tall grasses also grow. About half of the acreage of these soils is in native grasses and is used for grazing and hay. Some winter wheat is grown in cultivated areas. Also grown are oats, barley, corn, sorghums, alfalfa, and tame grasses.

Typical profile of Tuthill fine sandy loam, 0 to 5 percent slopes, in a cultivated area, 2,465 feet west and 2,000 feet north of the southeast corner, section 5, T. 38 N., R. 35 W.:

Ap—0 to 5 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist;

weak, fine, granular structure; soft, friable; neutral; abrupt, smooth boundary.

A12—5 to 9 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; very weak, coarse, prismatic structure breaking to weak, medium and fine, granular structure; soft, friable; neutral; clear, wavy boundary.

B21t—9 to 14 inches, light brownish-gray (10YR 6/2) sandy clay loam, dark grayish brown (10YR 4/2) when moist; moderate, medium, prismatic structure breaking to moderate, medium, subangular blocky structure; slightly hard, firm, slightly sticky; thin, very patchy clay films on vertical ped faces; neutral; clear, wavy boundary.

B22t—14 to 24 inches, light brownish-gray (10YR 6/2) clay loam, dark grayish brown (10YR 4/2) when moist; moderate, medium, prismatic structure breaking to moderate, medium and fine, blocky and subangular blocky structure; hard, firm, sticky; thin, continuous clay films on ped faces; neutral; clear, smooth boundary.

B3—24 to 29 inches, light brownish-gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) when moist; moderate, medium, prismatic structure breaking to moderate, medium and fine, subangular blocky structure; hard, friable, slightly sticky; thin, continuous clay films on faces of vertical peds and thin, patchy clay films on faces of horizontal peds; neutral; clear, wavy boundary.

IIC1—29 to 48 inches, light-gray (10YR 7/2) loamy sand, brown (10YR 5/3) when moist; very weak, medium, subangular blocky structure breaking to single grain; soft, very friable; mildly alkaline; gradual boundary.

IIC2—48 to 60 inches, light-gray and white (10YR 7/2, 8/1) loamy sand, light brownish gray and light gray (10YR 7/2, 6/2) when moist; single grain; loose; calcareous; moderately alkaline.

The A horizon ranges from 7 to 13 inches in thickness and from dark grayish brown to grayish brown in color. The B horizon ranges from 8 to 30 inches in thickness and from heavy sandy loam to clay loam in texture. In many places the most clayey part of the B horizon is entirely sandy clay loam, but in some places strata of clay loam are common and contain more silt and less sand than the sandy clay loam. In most places the underlying material is loamy sand or sand, but in some places below a depth of 40 inches there is an abrupt change to calcareous loamy material that contains small fragments of sandstone.

Tuthill soils have a more clayey subsoil than Holt soils and are more than 40 inches deep to sandstone. They also have a more clayey subsoil than Anselmo or Vetal soils. Tuthill soils are less silty and more sandy than Keith soils.

Tuthill and Anselmo fine sandy loams, 0 to 5 percent slopes (TnB).—These soils are level to gently undulating and occur on uplands in the eastern part of the county. Most areas are more than 40 acres in size, and a few are of as much as 800 acres. Some areas are mainly Tuthill soil, and others are mainly Anselmo. In many areas, however, both soils are present in varying amounts.

The Tuthill soil generally is on the longer, smoother slopes. The Anselmo soil occurs in the more undulating areas but in some places occurs at random in a complex pattern with the Tuthill soil. The Anselmo soil has a profile similar to the one described as typical for its series. The Tuthill soil has the profile described as typical for its series. In some cultivated areas, wind has winnowed the soil material and the surface layer has lost its structure and is loose.

Included with these soils in mapping are small tracts of Holt and Vetal soils. Holt soils are on the crest of some slopes. Vetal soils are in round-bottom swales. These included soils make up less than 10 percent of the mapped acreage.

More than half the acreage of these Tuthill and Anselmo soils is now or has been cultivated. Because soil blowing was common on these soils in the 1930's, some areas were seeded to tame grasses or they returned to native grasses. Oats, barley, corn, and alfalfa are the main crops now grown. Some winter wheat is grown also, but the risk of soil blowing is high.

Control of soil blowing and conservation of moisture are the main concerns of management on these soils. Management practices that maintain content of organic matter and soil structure help to control soil blowing. Proper range use helps control soil blowing on areas in native grass. (Sandy range site; capability unit IIIe-2; windbreak suitability group 1)

Tuthill and Anselmo fine sandy loams, 5 to 9 percent slopes (TnC).—These undulating soils are on uplands, mainly in the eastern part of the county. Most areas are as much as 400 acres in size. The Anselmo soil is dominant in some areas, but most areas are made up of varying amounts of both kinds of soils.

The Tuthill soil occupies the longer, smoother slopes. The Anselmo soil is in the more undulating areas but, in some mapped areas it occurs at random throughout. Each kind of soil has a profile similar to the one described as typical for its respective series, except that each has a slightly thinner surface layer that, in culativated areas, has been winnowed. Here the soil is loose.

Included with these Tuthill and Anselmo soils in mapping are small tracts of Dunday, Holt, Tassel, Valentine, and Vetal soils. Holt and Tassel soils are on a few of the ridges and knolls. Vetal soils are on foot slopes and in swales. Dunday and Valentine soils occur in some areas as spots of loose, sandy soils. Also included are a few small areas of sand blowouts, generally less than 1 acre in size. These included soils normally make up less than 20 percent of the acreage mapped.

Most areas of these soils are in native grasses. Some formerly cultivated areas have been seeded to tame grasses. On cultivated areas common crops are oats, barley, corn, and alfalfa. Some winter wheat also is grown, though the risk of soil blowing is high.

These soils are highly susceptible to blowing and to water erosion where the surface is unprotected. Management is needed that makes use of crop residues and other practices, such as wind stripcropping, that help control erosion of cultivated areas. On areas still in native grasses, proper range use helps control erosion. (Sandy range site; capability unit IVe-2; windbreak suitability group 1)

Ulysses Series

The Ulysses series consists of deep, gently sloping to rolling soils that formed in silty materials on the uplands.

In a typical profile the surface layer is grayish-brown silt loam about 6 inches thick. The subsoil, about 8 inches thick, is silt loam that is slightly hard when dry and is friable when moist. It is grayish brown in the upper part and is light brownish gray and calcareous in the lower part. The underlying material, light gray and calcareous, is silt loam in the upper part and very fine sandy loam in the lower part. It is calcareous throughout and has a few, fine, white streaks of soft lime in the upper part.

White, bedded, soft sandstone that is fine grained and calcareous is at a depth of 55 inches.

Ulysses soils are well drained. Surface runoff is medium, and permeability is moderate. These soils have high water-holding capacity and moderate natural fertility.

The native vegetation on Ulysses soils consists of mid and short grasses. Some areas are still in native grasses and are used for grazing and hay. Many areas, however, are cultivated, and winter wheat is the main crop.

In this county Ulysses soils are mapped only with Keith soils in an undifferentiated soil group.

Typical profile of Ulysses silt loam, 5 to 9 percent slopes, in a cultivated area, 1,400 feet west and 80 feet south of the northeast corner, section 19, T. 38 N., R. 40 W.:

Ap—0 to 6 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft, very friable; neutral; abrupt, smooth boundary.

B2—6 to 10 inches, grayish-brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) when moist; weak, coarse, prismatic structure breaking to weak and moderate, medium, subangular blocky structure; slightly hard, friable; mildly alkaline; abrupt, wavy boundary.

B3ca—10 to 14 inches, light brownish-gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) when moist; weak, coarse, prismatic structure; slightly hard, friable; calcareous; moderately alkaline; clear, smooth boundary.

C1ca—14 to 28 inches, light-gray (10YR 7/2) silt loam, pale brown (10YR 6/3) when moist; very weak, coarse, prismatic structure; soft, friable; calcareous with few, fine, distinct segregations of soft lime; moderately alkaline; gradual boundary.

C2—28 to 55 inches, light-gray (10YR 7/2) very fine sandy loam, pale brown (10YR 6/3) when moist; massive; soft, very friable; calcareous; moderately alkaline; clear boundary.

R—55 to 60 inches, white (10YR 8/2), soft, fine-grained sandstone, very pale brown (10YR 7/3) when moist; bedded; calcareous; moderately alkaline.

The A horizon ranges from 4 to 9 inches in thickness, from dark gray to grayish brown in color, and from very fine sandy loam to silt loam in texture. The B horizon ranges from 5 to 12 inches in thickness, and has about the same content of clay as is in the A horizon. In places the upper part of the B horizon is dark grayish brown. These soils are calcareous at a depth of 5 to 15 inches. In most places the silty C horizon extends downward 5 feet or more, but in many places the content of very fine sand increases with depth. Soft sandstone is at a depth below 40 inches.

Ulysses soils have a less clayey subsoil than Keith soils and are calcareous nearer the surface. They have a thicker grayish surface layer than Colby soils and are deeper to lime. In the Ulysses soils lime is nearer the surface than in the Oglala soils.

Valentine Series

This series consists of deep, undulating to hilly, sandy soils on the uplands in the southern and eastern parts of the county. These soils formed in sands deposited by wind.

In a typical profile the surface layer is grayish-brown fine sand about 4 inches thick. Just below is a 6-inch transitional layer consisting of light brownish-gray, loose fine sand. The underlying material is very pale brown, loose fine and medium sand.

The Valentine soils are excessively drained. Surface runoff is very slow, and permeability is rapid. Although these soils have a low capacity to hold moisture, they readily release this moisture to plants. Valentine soils have low natural fertility, and they are highly susceptible to soil blowing.

The native vegetation on Valentine soils consists mainly of tall and mid grasses. Nearly all areas are still in native grasses and are used for grazing. The Valentine soils are extensive in Bennett County and are important as rangeland.

Typical profile of a Valentine fine sand, 200 feet west of the southeast corner, section 15, T. 35 N., R. 37 W.:

A—0 to 4 inches, grayish-brown (10YR 5/2) fine sand, dark grayish brown (10YR 4/2) when moist; single grain; loose; neutral; clear, smooth boundary.

AC—4 to 10 inches, light brownish-gray (10YR 6/2) fine sand, grayish brown (10YR 5/2) when moist; single grain; loose; neutral; gradual, smooth boundary.

C—10 to 60 inches, very pale brown (10YR 7/3) fine and medium sand, pale brown (10YR 6/3) when moist; single grain; loose; neutral.

The A horizon ranges from 3 to 15 inches in thickness and from fine sand to loamy fine sand in texture. It is dark grayish brown to light brownish gray. In places where the darker color occurs, the A horizon does not exceed 4 inches in thickness. The AC horizon is intermediate between the A horizon and the C horizon in color. In some places the AC horizon is absent. The C horizon ranges from light gray to very pale brown.

The Valentine soils are lighter colored and more sandy than Anselmo and Dunday soils. They do not have limy layers like those in the Bankard soils.

Valentine fine sand, rolling (3 to 18 percent slopes) (VaC).—This undulating to rolling soil occupies a succession of rounded ridges and knolls on the uplands across the south side of the county. Slopes are short, mostly of less than 150 feet in length, but some of the slopes are longer and smoother (fig. 11). Areas are as much as 2,000 acres or more in size. The profile of this soil is similar to the one described as typical for the Valentine series.

Included with this Valentine soil in mapping are small tracts of Dunday, Elsmere, and Tassel soils. Dunday and Elsmere soils occupy small swales. Tassel soils are shallow over sandstone on some ridges where sandstone is close to the surface. Also included in many mapped areas are sand blowouts of as much as 2 acres in size. These included soils make up less than 10 percent of the acreage mapped.

Almost all of this soil is in native grasses and is used for grazing. The control of soil blowing is the main concern of management on this soil. Proper range use is the best way to control soil blowing. In some areas special management is needed to control sand blowouts. They start easily along stock trails and around watering places. (Sands range site; capability unit VIe-2; windbreak suitability group 6)

Valentine fine sand, hilly (15 to 35 percent slopes) (VaD).—This soil is scattered on the uplands across the south side of the county. It occupies the higher ridges in the sandhills. Slopes are short and in places are angular in shape (fig. 12). Most areas are smaller than those of Valentine fine sand, rolling, but some are as much as 1,500 acres in size.

In most areas the soil is lighter colored than the soil described as typical for the series. Included with this Valentine soil in mapping are areas of a more recently stabilized soil that has sparse plant cover. Also included in some mapped areas are pockets of the Dunday soils

Figure 11.—Valentine fine sand, rolling, in the foreground and Valentine fine sand, hilly, in background.

Figure 12.—Valentine fine sand, hilly.

and many spots of sand blowouts. These included areas generally are less than 10 percent of the acreage mapped.

Soil blowing, a constant hazard on this soil, is best controlled by proper range use. Seeding practices generally are not practicable, because slopes are steep. (Choppy Sands range site; capability unit VIIe–1; windbreak suitability group 6)

Valentine-Tassel complex, hilly (10 to 30 percent slopes) (VeD).—This complex is in the eastern part of the county. Most areas are as much as 1,000 acres in size. The Valentine soils make up 60 to 80 percent of the area, and the Tassel soils, 20 to 40 percent.

The Tassel soils are on the ridges and steeper slopes in the landscape. They have a profile similar to the one described as typical for the Tassel series. Valentine soils are on the less steep, middle parts of slopes below the ridges. In places the Valentine soils have calcareous sandstone at a depth below 30 inches.

Included in mapping this complex are small outcrops of sandstone in areas of Tassel soils. Also included are small tracts of Anselmo, Dunday, Holt, and Vetal soils. These tracts make up less than 15 percent of the acreage mapped.

All areas of this complex are in native grasses and are used for grazing. Soil blowing occurs in places where plant cover is disturbed. Proper range use helps control erosion. Seeding practices are feasible in some areas of the Valentine soils, but in most places the Tassel soils are on slopes too steep for mechanical treatment. (The Valentine soils are in the Sands range site, capability unit VIe–2, and windbreak suitability group 6; the Tassel soils are in the Shallow range site, capability unit VIIs–1, but a windbreak suitability group is not assigned)

Vetal Series

The Vetal series consists of deep, nearly level to sloping, loamy soils of the uplands. These soils occupy swales, fans, and foot slopes in the eastern part of the county. They developed in moderately sandy materials.

In a typical profile the surface layer is fine sandy loam about 22 inches thick. The upper 6 inches is dark grayish brown, and the lower part is dark gray. Just below is a transitional layer of grayish-brown fine sandy loam about 12 inches thick. It is soft when dry and very friable when moist. The underlying material consists of grayish-brown fine sandy loam and light-gray very fine sandy loam. It is soft to loose when dry and is very friable when moist.

Vetal soils are well drained. Surface runoff is slow to medium, and permeability is moderately rapid to rapid. These soils have low to moderate water-holding capacity. They have moderate to high natural fertility but are subject to soil blowing.

The native vegetation on Vetal soils consists of a mixture of tall, mid, and short grasses. Many areas are still in native grasses and are used for grazing and hay. In cultivated areas spring-sown grains, corn, sorghums, and alfalfa are the main crops. Some winter wheat is also grown.

Typical profile of a Vetal fine sandy loam in native grasses, 1,780 feet west (field gate) and 1,122 feet south of the northeast corner, section 15, T. 39 N., R. 36 W. (20 feet west of pasture trail):

A11—0 to 6 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark brown (10YR 2/2) when moist; very weak, medium and fine, subangular blocky structure; soft, very friable; neutral; clear, wavy boundary.

A12—6 to 22 inches, dark-gray (10YR 4/1) fine sandy loam, very dark brown (10YR 2/2) when moist; very weak, coarse, prismatic structure breaking to weak, coarse, subangular blocky structure; slightly hard, very friable; neutral; clear, wavy boundary.

AC—22 to 34 inches, grayish-brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; very weak, coarse, prismatic structure breaking to weak, coarse and medium, subangular blocky structure; soft, very friable; neutral; gradual, wavy boundary.

C1—34 to 42 inches, grayish-brown (10YR 4/2) when moist; very weak, coarse and medium, subangular blocky structure; soft to loose, very friable; neutral; gradual boundary.

C2—42 to 60 inches, light-gray (10YR 7/2) very fine sandy loam, brown (10YR 4/3) when moist; massive; soft, very friable; neutral.

The A horizon ranges from 14 to 25 inches in thickness, from dark gray to grayish brown in color, and from loamy very fine sand to sandy loam in texture. The AC horizon ranges from 8 to 20 inches in thickness and, when moist, is nearly as dark as the A horizon. In the C horizon texture ranges from very fine sandy loam to loose, medium and fine sand. In places, the C horizon contains fragments of sandstone and is calcareous in the lower part. Buried, dark-colored layers are common in the C horizon.

Vetal soils have thicker, darker-colored layers than the Anselmo, Dunday, or Tuthill soils. They are more sandy than the Goshen or Tuthill soils and do not have a clayey subsoil.

Vetal and Goshen soils, 0 to 3 percent slopes (VgA).—These soils occupy swales on the uplands in the eastern and northeastern parts of the county. Most areas are narrow and are less than 20 acres in size, but some areas are larger and are as much as 200 acres. Vetal soils are dominant in some areas, Goshen soils are dominant in a few areas, and in other areas both kinds of soils occur in significant amounts.

In areas where both kinds of soils occur, the Goshen soils are in the lower, more nearly level parts of the landscape. They have a loam surface layer and a clay loam subsoil and are less silty than the Goshen silt loam described as typical for its series. The Vetal soil has the profile described as typical for its series.

Included with these Vetal and Goshen soils in some areas are small tracts of Tuthill soils. They generally occur on slopes that merge into adjacent uplands. In most places they make up less than 15 percent of the acreage mapped.

About 50 percent of this mapping unit is cultivated. Suitable crops are winter wheat, oats, barley, corn, and alfalfa. These crops grow well.

Control of soil blowing is the main concern of management on the Vetal part of this mapping unit. Conserving moisture for plant use is the main management concern on the Goshen soil. Management is needed that uses crop residues so as to control erosion and conserve moisture on these soils. (Vetal soils are in the Sandy range site, capability unit IIIe–2, and windbreak suitability group 1; the Goshen soils are in the Overflow range site, capability unit IIc–1, and windbreak suitability group 2)

Vetal-Holt fine sandy loams, 6 to 15 percent slopes (VhD).—These soils occupy foot slopes below higher uplands (fig. 13) in the northeastern part of the county. Areas are as much as 400 acres in size. The Vetal soil makes up

Figure 13.—**Vetal-Holt fine sandy loams, 6 to 15 percent slopes, below Tassel soils on steeper slopes.**

60 to 80 percent of the area, and the Holt soil, 20 to 40 percent.

The Vetal soil occupies the plane and concave slopes in the landscape. The Holt soil is on rounded humps where depth to sandstone is moderate. Each kind of soil is similar to the one described as typical for its respective series, but in places there are fragments of sandstone in the Vetal soil.

Included with the Vetal and Holt soils in mapping are small areas of Anselmo, Dunday, Tassel, and Tuthill soils. These included areas make up less than 15 percent of the acreage mapped, but in many places they are absent.

Most areas of this mapping unit are in native grasses and are used for grazing and hay. Some of the more gentle slopes are cultivated, and alfalfa, the main crop, grows well. Native hay also grows well on these soils.

Control of soil blowing and water erosion are the main concerns of management on these soils. Management is needed that maintains a good plant cover on the areas in native grasses so as to help control erosion. On cultivated areas use of close-sown crops and of crop residues helps to control erosion. Use of these soils as cropland is not advisable where slopes are 9 percent or more. (Sandy range site; capability units IVe-2 where slopes are 6 to 9 percent, and VIe-1 where slopes are 9 to 15 percent; windbreak suitability group 1)

Use and Management of the Soils

This section discusses the use and management of soils for range and native hayland, for crops and tame pasture, for trees and shrubs in windbreaks, for wildlife, and for engineering uses.

Use of the Soils as Range [3]

Most of Bennett County originally was covered with grass, and about 68 percent is still grass covered. Mid and short grasses grow in the central and northern parts of the county. Tall and mid grasses are dominant in the Valentine soil association, which is almost entirely grass covered. The Valentine association is in the southern part of the county.

The rangeland in the county is chiefly rolling to hilly and is accessible for grazing. Small pastures of native grasses occur within extensive areas of cropland in the Keith-Rosebud association, which is in the central and western parts of the county. In all other parts of the county, cropland is in tracts surrounded by large areas of range.

Native grass for pasture and hay is a major crop in this county. It provides feed for breeding herds during

[3] By RALPH S. COLE, range conservationist, Soil Conservation Service.

periods of snow cover and furnishes grazing throughout the year. Beef cattle are the main kind of livestock. Sheep and hogs are few. Horses and dairy cattle are other kinds of livestock in the county.

To apply appropriate management, range operators need to know the kinds of rangeland in their pastures, the kinds of plants they can produce, and the effect of grazing on these plants. As a guide to range users, range sites and condition classes are defined.

Range sites and condition classes

A range site is a distinctive kind of range that, because of its combination of climate, soil, and topography, is capable of producing a particular kind and amount of native vegetation. The original, or climax, vegetation is made up of plants that make the best use of the natural environment and are the most productive. These plants reproduce themselves without aid of fertilizer, irrigation, or cultivation, but composition of the vegetation changes under intensive grazing.

Decreaser plants are a part of the climax vegetation. Ordinarily, they are the tallest and most productive perennial grasses and forbs and are the most palatable to livestock. They decrease if grazed closely (*5*). Increaser plants also are a part of the climax vegetation. They commonly are short grasses and are less palatable to livestock than the decreasers. These plants increase under close grazing and replace the decreasers. Invader plants are not normally a part of the climax vegetation. They invade areas where the climax vegetation is being depleted. Most invaders have little value for grazing.

Four range condition classes are recognized: excellent, good, fair, and poor. The classes are based on the degree of departure from climax vegetation. They show the differences between what is now growing on a particular site and the native vegetation that once grew there. A range is in excellent condition if 76 to 100 percent of the vegetation is the same kind as that in the original stand. It is in good condition if the percentage is between 51 and 75, in fair condition if the percentage is between 26 and 50, and in poor condition if the percentage is less than 25.

The following are signs of improvement in range condition: (1) the more palatable grasses are vigorous and are spreading; (2) little bare ground is visible, and there is an abundance of mulch; (3) grass is beginning to cover old gullies, and there are no active raw gullies; and (4) unwanted plants are few or lacking.

Signs that the range condition is deteriorating include the following: (1) desirable plants, such as big bluestem, little bluestem, green needlegrass, and leadplant amorpha, are gradually disappearing; (2) little grass mulch is visible, and there are increasing areas of bare ground; (3) gully erosion is active in the natural drainageways; and (4) pricklypear, fringed sagewort, curlycup gumweed, western ragweed, plantain, and other undesirable plants are gradually increasing.

Descriptions of range sites

The soils of Bennett County have been grouped into 12 range sites, which are described in the following paragraphs. Shown in each description are important soil characteristics, principal plants, and estimates of yields. The yield estimates are based on clipping studies and are for years when precipitation and temperature are average.

The mention of soil series in the descriptions of a range site does not mean that all the soils of the series are in the site. To find the range site in which a given soil has been placed, and the page on which it is described, turn to the "Guide to Mapping Units" at the back of this survey. Marsh is not suitable for use as range and has not been placed in a range site.

WETLAND RANGE SITE

Gannett fine sandy loam is the only soil in this range site. It is a very poorly drained, black, loamy soil that has a fibrous peaty layer at the surface. It occurs adjacent to marshes and lakes in and near the Valentine association. The water is at the surface early in the growing season, but it slowly drops to a depth of 6 to 20 inches late in the summer.

Decreaser plants include slough sedge, prairie cordgrass, northern reedgrass, bluejoint reedgrass, and reed canarygrass. The increaser plants include slim sedge and common rush. The main invaders are Kentucky bluegrass, Canada bluegrass, foxtail barley, timothy, and Canada-thistle.

Most of the acreage of this range site is used for hay. Grazing should be avoided in spring and early in summer so as to prevent damage by trampling.

If this site is in excellent condition, the total annual yield of herbage is about 5,800 pounds, air-dry weight, per acre. Of this total, about 85 percent is made up of plants that provide forage for cattle.

SUBIRRIGATED RANGE SITE

In this site are deep, dark-colored Elsmere, Lamo, and Loup soils and Alluvial land. These developed under the influence of a water table. They occupy basins and valleys in and near the Valentine soil association and flood plains along many of the intermittent streams in the county. The soils range from silt loam to loamy fine sand in texture. The water table is close to the surface early in the growing season and usually drops to a depth of 2 to 5 feet by midsummer. Moisture from the water table is within the reach of plant roots during most of the growing season.

The decreaser plants include big bluestem, switchgrass, little bluestem, prairie cordgrass, and indiangrass. The increasers include western wheatgrass and slim sedge. The main invaders are Kentucky bluegrass, foxtail barley, Canada-thistle, and verbena.

Many areas of this range site are used for hay (fig. 14). Red clover has been introduced in some areas.

If this site is in excellent condition, the total annual yield of herbage is about 4,800 pounds, air-dry weight, per acre. Of this total, about 90 percent is made up of plants that provide forage for cattle.

SALINE LOWLAND RANGE SITE

In this site are saline-alkali soils that have a water table that fluctuates between the soil surface and a depth of about 5 feet. Because of this fluctuating water table, salts are in the soil within 10 inches of the surface. The site consists of Minatare soils and is mainly in the

371-550—71——4

Figure 14.—**Subirrigated range site used for hay. The trees, shrubs, and water on this site benefit wildlife.**

Mosher-Minatare-Loup soil association on flats and in valleys that are only a few feet above the adjacent Subirrigated range site.

The principal decreaser plants are prairie cordgrass, switchgrass, prairie sandreed, western wheatgrass, alkali sacaton, and alkali cordgrass. The main increaser plant is inland saltgrass. The invaders include kochia, pursh seepweed, Kentucky bluegrass, and foxtail barley.

Most of this site is used for grazing. A few areas are used for hay. Grazing should be avoided in spring so as to prevent damage by trampling. Unless extreme care is used in management, range condition declines and inland saltgrass increases to an almost pure stand. Then the site has little value for grazing and no value for hay. If this site is in excellent condition, the total annual yield of herbage is about 3,500 pounds, air-dry weight, per acre. Of this total, about 80 percent is made up of plants that provide forage for cattle.

OVERFLOW RANGE SITE

This site consists of loamy soils in alluvium on bottom lands and of dark-colored, silty soils in upland swales. The site occasionally is flooded by streams, by runoff from adjacent upland slopes, or by both. On the alluvial bottom lands the soils have a water table that is below the reach of grass roots. The soils in this site are in the Goshen and Haverson series.

The principal decreaser plants are big bluestem, green needlegrass, little bluetsem, prairie sandreed, and switchgrass. The increaser plants include western wheatgrass, needle-and-thread, sideoats grama, and blue grama. The invaders include curlycup gumweed, Japanese brome, common sunflower, Kentucky bluegrass, kochia, and western ragweed.

Many areas of the Goshen soils are cultivated. Some areas of the Haverson soil are also cultivated, but most areas are in native grass and are used for grazing and hay. Native trees and shrubs grow in a few clumps on some parts of the bottom land.

If this site is in excellent condition, the total annual yield of forage is about 3,200 pounds, air-dry weight, per acre. Of this total, about 90 percent is made up of plants that provide forage for cattle.

CLOSED DEPRESSION RANGE SITE

Hoven silt loam is the only soil in this range site. This soil has a claypan and takes in water slowly. It occurs in closed depressions that collect runoff from the adjacent

slopes. The depressions lack outlets and are ponded until the water is absorbed or evaporated.

The major decreaser plant is western wheatgrass. Small sedges and rushes are the main increasers, and buffalograss is an increaser in some of the drier areas. Foxtail barley, knotweed, and other invaders take over if the areas are ponded for long periods or are intensively grazed and trampled when the soil is wet.

In the Keith-Rosebud association, many areas of this soil are cultivated. Some areas are mowed for hay.

If this site is in excellent condition, the total annual yield of herbage is about 3,000 pounds, air-dry weight, per acre. Of this total, about 90 percent is made up of plants that provide forage for cattle.

SANDS RANGE SITE

This site consists of deep, loose, sandy soils on undulating to rolling uplands in the southern and eastern parts of the county. These soils are highly susceptible to soil blowing. The Bankard and Valentine soils and Blown-out land are in this site.

Decreaser plants include sand bluestem, big bluestem, little bluestem, switchgrass, and leadplant amorpha.

Prairie sandreed and needle-and-thread are important increasers. Other increasers are blue grama, hairy grama, sand dropseed, threadleaf sedge, field sagewort, and yucca. The invaders are sandbur, western ragweed, annual bromegrass, and annual dropseed.

This site, one of the most extensive in the county, is used almost entirely for grazing. Careful range management is needed to prevent sand blowouts. Treatment that stabilizes dunes helps to restore the blowouts to usable range.

If this site is in excellent condition, the total annual yield of herbage is about 2,700 pounds, air-dry weight, per acre (fig. 15). Of this total, about 85 percent is made up of plants that provide forage for cattle.

SANDY RANGE SITE

In this site are deep and moderately deep, dark-colored, loamy and sandy soils. In most areas the soils are nearly level to rolling and occur on uplands in the eastern part of the county. These soils are in the Anselmo, Dunday, Holt, Tuthill, and Vetal series.

The main decreaser plants are prairie sandreed, little bluestem, sand bluestem, big bluestem, and switchgrass. The increaser plants include western wheatgrass, needle-and-thread, blue grama, sand dropseed, threadleaf sedge, and green sagewort. The invaders include annual bromegrass, western ragweed, common sunflower, Russian thistle and plantain.

Scattered areas of this site are cultivated, but most areas are used for grazing and hay. Some formerly cultivated areas were damaged by soil blowing in the 1930's and have been reseeded to either tame or native grasses.

If this site is in excellent condition, the total annual yield of herbage is about 2,500 pounds, air-dry weight, per acre. Of this total, about 85 percent is made up of plants that provide forage for cattle.

***Figure 15.*—Sands range site in good condition under full use.**

SILTY RANGE SITE

This site consists of moderately deep and deep, silty and loamy soils. These soils of the uplands are nearly level to hilly and occur in all parts of the county north of the sandhills. The soils are in the Altvan, Dawes, Goshen, Kadoka, Keith, Oglala, Richfield, Rosebud, and Ulysses series.

Western wheatgrass and green needlegrass are the main decreasers, and there are smaller amounts of big bluestem, little bluestem, and prairie sandreed. The increasers include needle-and-thread, blue grama, and fringed sagewort. The invaders include annual bromegrass, curlycup gumweed, plantain, and Russian-thistle.

Extensive areas of this site in the Keith-Rosebud soil association are cultivated. In the Oglala-Canyon association, this site is mostly used for grazing and hay. It is one of the most productive upland range sites in the county.

If this site is in excellent condition, the total annual yield of herbage is about 2,200 pounds, air-dry weight, per acre. Of this total, about 90 percent is made up of plants that provide forage for cattle.

CLAYPAN RANGE SITE

In this site are deep Mosher soils that have a moderately thick to thick surface layer and a claypan in the subsoil. These soils are in nearly level valleys and on flats, mainly in the Mosher-Minatare-Loup soil association. The surface layer is friable and takes in moisture readily, but the clayey subsoil slows the penetration of moisture and roots.

Western wheatgrass is the main decreaser plant. The increaser plants include blue grama, inland saltgrass, and buffalograss. The invaders include annual bromegrass, Kentucky bluegrass, curleycup gumweed, blue verbena, and common sunflower.

Some areas of this site are cultivated; alfalfa is the main crop. Most areas are in native grass and are used for grazing and for hay. If this site is in excellent condition, total annual yield of herbage is about 1,500 pounds, air-dry weight, per acre. Of this total, about 90 percent is made up of plants that provide forage for cattle.

CHOPPY SANDS RANGE SITE

Valentine fine sand, hilly, is the only soil in this range site. It consists of light-colored, loose sand. It occupies more abrupt and more irregular slopes than the soils in the Sands range site. Most of the slopes are 20 percent or more. Narrow ridges and peaks that are angular in shape are common. Sand blowouts are scattered in many areas. This site is in the hilly parts of the Valentine soil association.

The principal decreaser plants are sand bluestem, big bluestem, little bluestem, and leadplant amorpha. The increaser plants include prairie sandreed, needle-and-thread, sand dropseed, blue grama, hairy grama, and yucca. The invaders include sandbur and western ragweed.

All of this range site is used for grazing. Management is needed that prevents sand blowouts.

When this site is in excellent condition, the total annual yield of herbage is about 2,100 pounds, air-dry weight, per acre. Of this total, about 80 percent is made up of plants that provide forage for cattle.

THIN UPLAND RANGE SITE

The Colby soil in Keith-Colby silt loams, 9 to 12 percent slopes, is the only soil in this range site. It is a thin soil that formed in calcareous silty material. It is friable, moderately permeable, and somewhat excessively drained. It occupies the tops of ridges and knolls in all parts of the county north of the sandhills.

The decreaser plants include little bluestem, green needlegrass, and western wheatgrass. The main increaser plants are side-oats grama, needle-and-thread, blue grama, and threadleaf sedge. The invaders include broom snakeweed, curlycup gumweed, and annuals.

Some areas of this site are cultivated, but most areas are in native grass and are used for grazing. If this site is in excellent condition, the total annual yield of herbage is about 1,850 pounds, air-dry weight, per acre. Of this total, about 85 percent is made up of plants that provide forage for cattle.

SHALLOW RANGE SITE

This site consists of shallow, loamy soils that are 5 to 20 inches deep to bedded sandstone, siltstone, or gravel. The bedded sandstone is relatively soft, but it is interbedded with hard sandstone layers in places. It is rich in lime. Only a few fine roots extend below a depth of 15 inches. The soils are rolling to hilly and occur on uplands (fig. 16) in all parts of the county north of the sandhills. In this range site are Gravelly land and Canyon, Epping, and Tassel soils.

The decreaser plants include little bluestem, western wheatgrass, green needlegrass, and prairie sandreed. Big bluestem and sand bluestem are decreasers on the more sandy soils. Side-oats grama, an important increaser, is the first to replace the decreasers. Other increasers are needle-and-thread, blue grama, and threadleaf sedge. The invaders include broom snakeweed, plantain, and annual brome.

In the central part of the county, small areas of this site are cultivated. All other areas are used for grazing.

If this site is in excellent condition, the annual yield of herbage is about 1,800 pounds, air-dry weight, per acre. Of this total, 80 percent is made up of plants that provide forage for cattle.

Range management practices

Conservation of water and control of erosion are the major management needs for range improvement in this county. Measures effective in meeting these needs include proper degree of use; proper season of use; deferment or distribution of grazing; range seeding; pitting and contour furrowing; dune stabilization; control of fire, brush, and weeds; and water spreading.

Proper degree of use, under which not more than half of the yearly growth of forage is eaten, benefits all range sites and is especially beneficial on the Sands range site. Proper season of use varies according to the range site. The sites should be grazed when the vegetation grows best. The Silty and the Claypan range sites are examples of sites that produce cool-season grasses, such as western wheatgrass and green needlegrass. The Shallow and the Sands range sites are examples of sites that produce warm-season grasses, such as bluestem and prairie sandreed.

Figure 16.—**Shallow range site.**

Deferment of grazing is the practice of excluding livestock during part or all of a growing season. The Shallow and the Sands range sites are examples of sites on which grazing should be deferred in summer and early in fall. The Silty and the Claypan range sites are examples of sites on which grazing should be deferred in spring and early in summer. Distribution of grazing can be effected by fencing and by spacing water facilities and salting areas.

Range seeding helps to reestablish native grasses on rangeland that is in poor or fair condition and on cropland that is being converted to range. Native grasses should be used. For example, the seeding mixture should consist of western wheatgrass and green needlegrass on the Claypan and the Silty range sites. It should consist of little bluestem and side-oats grama on the Shallow range site and of sand bluestem, prairie sandreed, and little bluestem on the Sands range site.

Range pitting helps retard runoff and conserve moisture. It encourages the growth of taller grasses and is beneficial if the range is in poor or fair condition. The slope should be less than 10 percent. Contour furrowing also encourages growth of the taller grasses and is suitable if the slopes are as much as 20 percent. Examples of range sites benefited by pitting and furrowing are the Sandy and Silty range sites. Grazing in pitted areas should be deferred for two growing seasons.

Dunes can be stablized by smoothing, fencing, and mulching the areas, or by establishing a cover of rye or sudangrass and then seeding the range. Areas in need of dune stablization occur in the Sands and Choppy Sands range sites. Firebreaks are especially needed on the Silty and the Shallow range sites. Control of brush is particularly effective on the Sands and the Sandy range sites.

Management of native haylands

Native, or wild, hay is an important crop in the county. In this county wild hay was harvested on an average of 38,200 acres per year during the period 1949 to 1965, and ranged from 52,500 acres in 1949 to 25,000 acres in 1963 (*16*). From 1949 to 1963, yields of wild hay averaged 0.7 ton per acre and were highest in 1960, when the average was 1.0 ton per acre.

Grasses cut early provide hay with better feeding value than grasses cut late in summer, which have more tonnage (*6*). The usual practice is a compromise between the higher feed value of hay cut early and the greater tonnage of hay cut late.

The Wetland, the Subirrigated, and the Saline Lowland range sites are the most productive sites for hay in the county. Hay meadows on these sites usually can be mowed annually, and they yield as much as 2 tons per acre. Grazing in the spring and immediately after mowing may cause the grass stand to deteriorate, but grazing in the winter affects yields in the following year very little.

The condition of upland range sites, such as the Sandy

and the Silty sites, declines if the grasses are mowed more often than once in 2 years. On upland sites it is desirable to use equipment that does not rake up the grass mulch.

Hay meadows can be improved by water spreading, a practice of diverting and spreading runoff water by use of dams, ditches, and dikes. The additional moisture stimulates the growth of grasses, and the yields of hay increase. Most of the favorable sites for water spreading are on the Silty and the Overflow range sites along intermittent streams in the northern part of the county.

Management of Cropland[4]

Cropland makes up about 23 percent of the total land area of this county. Most of it is in the Keith-Rosebud soil association in the central and west-central parts of the county.

Soils used for cultivated crops need management that conserves moisture, controls water erosion and soil blowing, and maintains or improves tilth and fertility.

Conserving moisture and controlling erosion

In Bennett County conserving moisture is essential for good growth of crops. Winter wheat, the main cereal crop, is commonly grown in a 2-year sequence of wheat and fallow, but this practice encourages both soil blowing and water erosion.

The critical periods for the Keith, Richfield, and similar soils are winter and early in spring, for then wind velocities are high and the surface soil has been loosened by frost action. If there is not enough crop residues in and on the surface layer of these soils, soil blowing cuts off the leaves of young wheat plants and covers up the plants (fig. 17). Also, soil blowing damages Anselmo, Dunday, Tuthill, and similar soils if the plant cover is not adequate for protection. The Keith, Richfield, Rosebud, and other productive soils are subject to washing during intense summer rainstorms in areas where clean fallow is practiced.

Practices needed to control soil blowing and water erosion include use of crop residues, stubble mulching, stripcropping, a cropping system that includes soil-improving crops, terracing and contour farming, grassed waterways, and emergency tillage.

Leaving enough crop residues on the surface, or mixing it into the surface layer, protects the soil from blowing and washing during critical periods. In addition, use of crop residues returns organic matter to the soil, helps to maintain fertility, improves tilth, and aids in absorption of rainfall. This practice used alone helps to reduce soil losses to a minimum and to conserve moisture on the nearly level Keith, Richfield, Rosebud, and similar soils.

Stubble mulching is a system of managing crop residues during seedbed preparation, planting, cultivation, and after harvesting so as to keep a protective cover on the surface the year round. The residues make a mulch that protects the soil and conserves moisture as well. Stubble mulching is effective on all cropland in the county and is especially effective on the Anselmo, Keith, Oglala, Tuthill, and similar soils. Soil texture and the degree of slope determine the amount of residue needed per acre. Help in determining the amount needed can be obtained from the local office of the Soil Conservation Service or from the Bureau of Indian Affairs.

Stripcropping is the practice of alternating strips of close-growing crops with strips of row crops or fallow. Laying out the strips at right angles to the prevailing winds helps to control soil blowing. The Anselmo, Dunday, and Tuthill soils are examples of soils that benefit from stripcropping. Contour stripcropping helps to control water erosion on the gently sloping Keith and Rosebud soils.

A cropping system that includes legumes, grasses, or other soil-improving, high-residue crops helps to keep soils in good tilth and to maintain fertility. Use of this system may reduce the need for other practices in controlling erosion on the Anselmo, Dunday, and similar soils.

Terracing and contour farming, generally used in combination, are effective in conserving moisture and controlling water erosion on cropland that has slopes of more than 2 percent. Among the soils that need such protection are the Keith and Richfield soils.

Grassed waterways are broad grass-covered channels used to carry runoff at a nonerosive rate. They generally are needed on gently sloping Keith and Rosebud soils (fig. 18).

Roughening the soil surface by listing, ridging, duckfooting, or chiseling is an effective practice where there is not enough crop residue or growing vegetation to protect the soil against blowing.

Maintaining tilth and fertility

Tilth and fertility are difficult to maintain in areas that have limited precipitation. Effective practices for soil improvement include the use of minimum tillage, high-residue crops, and commercial fertilizers.

Fallowed fields should be tilled only enough to control weeds. Frequent tillage of Dawes, Keith, Richfield, and similar soils tends to pulverize the surface layer and to impair soil structure and tilth. These soils then puddle and crust, fail to absorb water readily, and become more susceptible to soil blowing and water erosion. Frequent tillage also leads to the formation of a tillage pan, or traffic pan, immediately below plow depth. Formation of a pan is avoided by not working the soils when they are wet and by changing the depth of tillage. A pan can be broken up by chiseling every third or fourth year and by growing deep-rooted legumes and grasses.

Growing high-residue crops helps to maintain the organic-matter content in Keith, Richfield, and similar soils. Green manure and manure obtained from feedlots help to maintain or increase the organic-matter content in Anselmo and other sandy soils and in Colby and other soils that are rich in lime.

The soils in Bennett County have been cultivated for a relatively short time, and they generally have produced well without additions of commercial fertilizers. Soils rich in lime, such as the Colby, are low in organic-matter content and normally are low in available nitrogen and phosphorus. A nitrogen deficiency occasionally shows up

[4] By Walter N. Parmeter, conservation agronomist, Soil Conservation Service.

Figure 17.—**Wind blasting field of Keith soils that has insufficient residues for protection. Much of the finer, more fertile part of the surface layer has blown away.**

in fields of Keith and Rosebud soils that have been in continuous cultivation for 40 years or more. Such a deficiency is more likely to occur during or after years of above-average rainfall. The decline of organic-matter content and fertility is fairly rapid in Anselmo and Dunday soils when those soils are cultivated.

Recent field trials showed that winter wheat grown after fallow on Keith, Richfield, and Rosebud soils has little or no response to the application of nitrogen and phosphorus. Spring-sown small grains grown after another crop on Keith and Richfield soils showed only slight response to applications of nitrogen.

The need for fertilizers is likely to increase. Information on soil testing and on the use of commercial fertilizers can be obtained from the county agricultural agent or the Soil Conservation Service.

Irrigating

Only about 300 acres in Bennett County are irrigated. Near the village of Tuthill, a few small tracts of Anselmo and Keith soils are irrigated by sprinklers. On these tracts corn for silage and alfalfa are the main crops. The irrigation water is obtained from wells. Gravity irrigation systems provide supplemental water for small tracts of hay meadow in the Mosher-Minatare-Loup-association. Springs on the edge of the sandhills supply water for those gravity systems. Successful irrigation requires suitable soils, enough water of good quality, and an efficient means of delivering the water. Good management requires a knowledge of how to apply water, when to apply it, and how to distribute it evenly. Also, most soils need to be fertilized if crops are to benefit fully from irrigation. Help in planning an irrigation system can be obtained

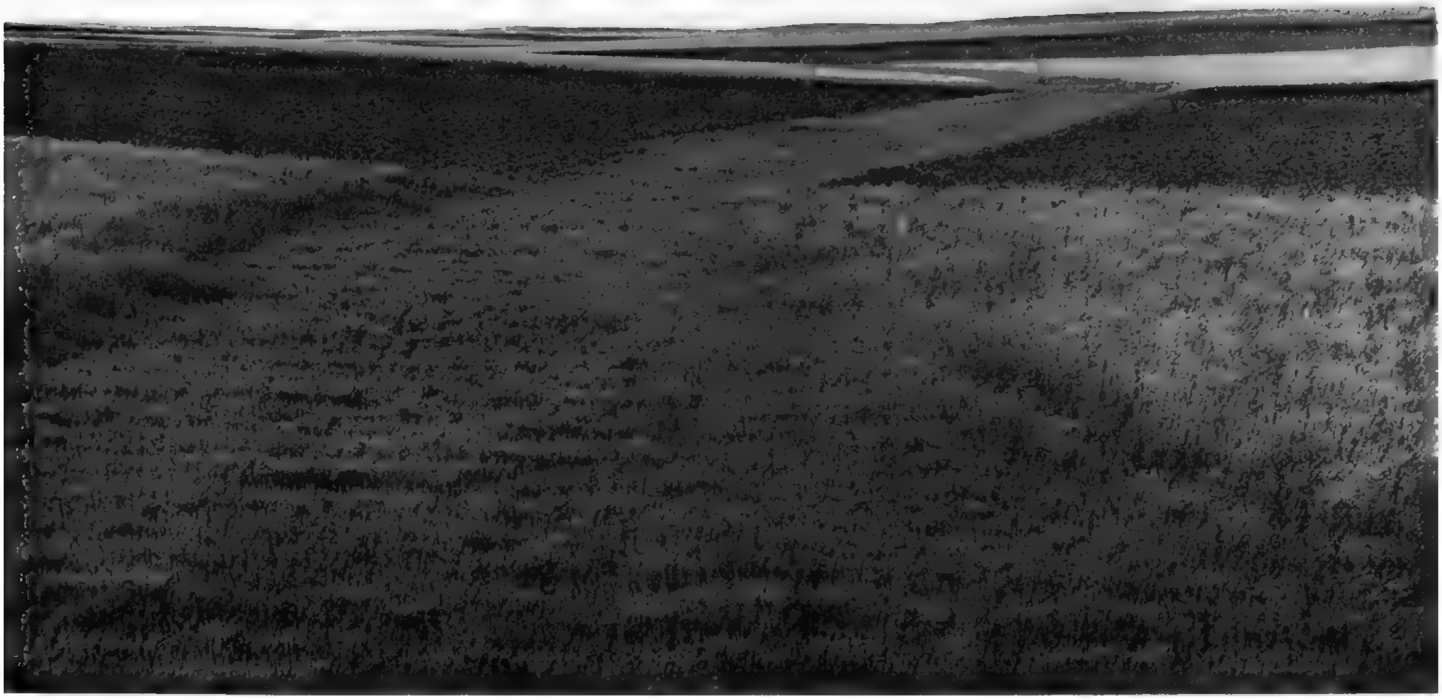

Figure 18.—**Grassed waterway in a stripcropped field of Keith and Rosebud soils.**

from the Soil Conservation Service, the Bureau of Indian Affairs, and the Agricultural Extension Service of the South Dakota State University.

Cropland used for tame pasture

Some areas of cropland in Bennett County are used for tame grasses and legumes. Most of these areas are in the east-central part of the county and consist of Anselmo and Tuthill soils. A few areas of Keith and Rosebud soils in other parts of the county also are used for tame pasture. Crested wheatgrass and intermediate wheatgrass are the main grasses used for tame pasture. Management practices that benefit pasture are proper use, rotation grazing, and adding fertilizer as needed.

Capability grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The groups are made according to the limitations of the soils when used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops requiring special management.

Those familiar with the capability classification can infer from it much about the behavior of soils when used for other purposes, but this classification is not a substitute for interpretation designed to show suitability and limitations of groups of soils for range, for forest trees, or engineering (*10*).

In the capability system, all kinds of soils are grouped at three levels, the capability class, subclass, and unit. These are discussed in the following paragraphs.

Capability Classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use, defined as follows:

- Class I soils have few limitations that restrict their use.
- Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.
- Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.
- Class IV soils have very severe limitations that reduce the choice of plants, require very careful management, or both.
- Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife.
- Class VI soils have severe limitations that make them generally unsuited to cultivation and limit their

use largely to pasture or range, woodland, or wildlife.

Class VII soils have very severe limitations that make them unsuited to cultivation and that restrict their use to pasture or range, woodland, or wildlife.

Class VIII soils and landforms have limitations that preclude their use for commercial plants and restrict their use to recreation, wildlife, or water supply, or to esthetic purposes.

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only the subclasses indicated by *w*, *s*, and *c*, because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture, range, woodland, wildlife, or recreation.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe-1 or IIIs-2. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass.

In the following pages the capability units in Bennett County are described and suggestions for the use and management of the soils are given. In the description of a capability unit the mention of a soil series does not mean that all soils in the series are in the unit.

CAPABILITY UNIT IIe-1

This unit consists of deep and moderately deep, gently sloping silt loams and loams on uplands. These soils are in the Goshen, Kadoka, Keith, Oglala, Richfield, and Rosebud series. They are slightly eroded to moderately eroded in many cultivated fields.

The soils in this unit have good tilth, are moderate to high in water-holding capacity, and are moderately permeable. They wash and blow if management is not good, and moisture deficiencies occur in some years. Management is needed for controlling erosion, conserving moisture, and maintaining fertility and good tilth.

Suitable crops are wheat, oats, barley, corn, rye, sorghums, alfalfa, and tame grasses. Winter wheat, the main crop, grows well in a sequence with summer fallow.

Stubble mulching, used alone or in combination with crop residue and contour farming, helps to control erosion. Terracing, stripcropping, and use of field windbreaks also help to control erosion, and they help to conserve moisture as well. If tame grasses and legumes are included in the cropping system, the need for other practices of erosion control is lessened. Grassed waterways help to remove excess water from fields without allowing damaging erosion.

CAPABILITY UNIT IIw-1

Haverson loam, 0 to 3 percent slopes, is the only soil in this capability unit. This soil is on bottom lands along the Little White River in the central part of the county and along intermittent streams in the northern part. Flooding, which generally occurs once in 5 years, destroys fences and deposits sediments and debris in small areas. Flexible management that can be adjusted for periods of flooding is needed.

Alfalfa is the main crop, but wheat, oats, barley, rye, sorghums, corn, and tame grasses also are suitable. Flood damage is minimized by growing grasses and legumes, plants that are least affected by flooding.

CAPABILITY UNIT IIc-1

This unit consists of deep and moderately deep, nearly level silt loams and loams on uplands and stream terraces. These soils are in the Goshen, Keith, Oglala, Richfield, and Rosebud series. Moisture is periodically deficient because the amount and distribution of annual rainfall are irregular on these soils.

The soils in this unit have moderate fertility and are in good tilth. Permeability is moderate, and water-holding capacity is moderate to high. The main management concern is conservation of moisture for plant use. Soil blowing is a secondary concern.

Wheat, oats, barley, rye, corn, sorghums, alfalfa, and tame grasses are suitable crops. Winter wheat, the main crop, is grown in sequence with summer fallow. Where management practices are adequate, crops grow well.

Management that supplies organic matter and helps to maintain fertility and good tilth also conserves moisture and helps to control soil blowing. Use of crop residue helps to conserve moisture and limits losses from erosion. Stubble mulching is desirable when summer fallow is included in the cropping system. Although other management practices generally are not needed, wind stripcropping and field windbreaks are desirable in places.

CAPABILITY UNIT IIIe-1

Keith, Rosebud, and Ulysses soils are in this unit. These soils are moderately deep and deep and, in many cultivated areas, slightly to moderately eroded.

The soils in this unit have steeper slopes than the soils in unit IIe-1 and need more intensive management for controlling water erosion.

Suitable crops on the soils in capability unit IIIe-1 are wheat, oats, barley, rye, corn, sorghums, alfalfa, and tame grasses. Winter wheat, grown after a season of fallow, is the main crop and has good growth.

A combination of stubble mulching and contour farm-

ing, or of terracing and use of crop residue, helps to control erosion and to conserve moisture. Erosion can be controlled by using crop residue alone on areas where grasses and legumes are grown half of the time. Stripcropping and field windbreaks also help to control erosion, as does the grassing of natural drainageways.

CAPABILITY UNIT IIIe-2

This unit consists of deep, nearly level to gently undulating, loamy soils on uplands. These soils are in the Anselmo, Holt, Tuthill, and Vetal series. Where these soils are cultivated, most areas are slightly to moderately eroded.

These soils are worked easily. They take in water readily, and their permeability is moderate to moderately rapid. Water-holding capacity is moderate to low. In cultivated areas, the structure of the surface layer is destroyed easily and the soils are highly susceptible to soil blowing unless management is used that helps maintain content of organic matter. Such management also conserves moisture.

Spring-sown small grains, corn, alfalfa, and tame grasses are suitable crops. Some winter wheat is grown on Holt and Tuthill soils, but intensive management is needed to control soil blowing on those soils.

Stubble mulching or a combination of wind stripcropping and use of crop residue helps to control soil blowing and conserve moisture. Also desirable on the soils of this unit are field windbreaks and use of grasses and legumes in the cropping system.

CAPABILITY UNIT IIIs-1

In this unit are deep, nearly level soils that have a thick silt loam surface layer over a claypan subsoil. These soils are in the Dawes series.

The soils in this unit have moderate fertility and high water-holding capacity. Because the claypan subsoil slows the penetration of moisture and the development of roots, the choice of crops is limited in years of low rainfall.

Wheat, oats, barley, rye, alfalfa, and tame grasses are suitable crops. Winter wheat is the main crop grown. Row crops generally are not suitable.

The main management concerns on these soils are maintaining good tilth and content of organic matter. Control of soil blowing is a secondary concern. Crop residue used alone helps to control erosion and to maintain content of organic matter and good tilth. Stubble mulching is desirable, especially where winter wheat is grown in a sequence with summer fallow. By planting deep-rooted legumes, such as alfalfa and sweet clover, the penetration of moisture into the subsoil is encouraged.

CAPABILITY UNIT IIIs-2

The only soil in this unit is Altvan loam, 0 to 5 percent slopes. This soil is moderately deep over gravelly material. It occurs on terraces and benches, mainly in the northeastern part of the county.

This soil has moderate fertility and is easy to work. Because it is moderately deep to gravel and droughty, choice of crops is limited.

Wheat, oats, barley, sorghums, and tame grasses are suitable crops. Alfalfa and corn are suitable in places where the gravel contains a large amount of fine earth.

Management is needed that helps to conserve moisture. Control of soil blowing is a secondary concern. Crop-residue use or stubble mulching helps to conserve moisture and to control erosion. Strip-cropping helps to control erosion on fields that are susceptible to soil blowing.

CAPABILITY UNIT IVe-1

Keith-Colby silt loams, 9 to 12 percent slopes, are the only soils in this unit. These deep soils occur on uplands and are susceptible to erosion if they are cultivated.

These soils are in good tilth and have high water-holding capacity. They are easy to work, but intensive practices are needed to control water erosion.

Wheat, oats, barley, rye, and alfalfa are suitable crops. Winter wheat is the main crop. Row crops are less suitable because slopes are steep.

On these soils, management is needed that controls water erosion, conserves water, adds organic matter, and helps to maintain fertility and good tilth. Stubble mulching, in combination with terracing and contour farming, helps to control erosion and to conserve moisture. Use of grasses and legumes in the cropping system supplies organic matter, helps to maintain fertility and good tilth, and lessens the need for erosion control. Grassed waterways help to control erosion along the natural drainageways.

CAPABILITY UNIT IVe-2

This unit consists of deep and moderately deep, gently sloping, loamy soils on uplands. These soils are in the Anselmo, Holt, Tuthill, and Vetal series. In cultivated areas, both soil blowing and water erosion are slight to moderate.

These soils take in water easily but have only moderate to low water-holding capacity. In cultivated areas, content of organic matter decreases and soil blowing and water erosion are likely.

Spring-sown small grains, alfalfa, corn, soybeans, and tame grasses are suitable crops. Some winter wheat is grown on the Holt and Tuthill soils, but intensive management is needed to control soil blowing on those soils.

Management that maintains content of organic matter and conserves moisture also helps control soil blowing and water erosion. Stubble mulching, combined with stripcropping, helps to control erosion and to conserve moisture in areas that are used intensively. Field windbreaks help to control soil blowing. Use of crop residue controls erosion in areas where grasses and legumes are grown for half or more of the time.

CAPABILITY UNIT IVe-3

This unit consists of deep loamy fine sands of the Dunday series. The Dunday soils are gently undulating.

The soils in this unit have low to moderate natural fertility and low water-holding capacity. They are loose and blow easily if cultivated.

Oats, barley, corn, sorghums, alfalfa, and tame grasses are suitable crops, but winter wheat and rye are not.

Management that maintains or increases the content of organic matter also helps to control erosion. For controlling soil blowing, an adequate cover of growing crops or of crop residue is needed throughout the year. Summer fallow can be hazardous on these soils. Tame grasses and

alfalfa in the cropping system help to control erosion. Where these soils are in annual crops, stubble mulching and wind stripcropping help to control soil blowing. Field windbreaks also are helpful in controlling soil blowing.

CAPABILITY UNIT IVw-1

The Elsmere soil in Dunday and Elsmere loamy fine sands is the only soil in this unit. This soil is deep and has a water table at moderate depths. It occurs in and near the Valentine soil association in the southern part of the county. In wet years the fluctuating water table drowns out some crops. In dry years this loose sandy soil blows easily if the surface is not protected by residues or growing plants. Management is needed that adjusts to these contrasting conditions.

Most areas are in native grasses and are used either for hay or for grazing. Where this soil is cultivated, alfalfa and tame grasses are the most suitable crops. If management is intensive, spring-sown small grains and corn can be grown.

Where this soil is in annual crops, stubble mulching and stripcropping help to control soil blowing. Field windbreaks are desirable in places. Because these soils occasionally are wet and are susceptible to soil blowing, they should be kept in grasses and legumes most of the time.

CAPABILITY UNIT IVs-1

The Mosher soil in Mosher-Minatare complex is the only soil in this capability unit. This soil is deep and has a moderately thick, silty surface layer and a claypan subsoil. It is nearly level and occupies valleys and flats, mainly in the Mosher-Minatare-Loup association.

The soil in this unit has moderate natural fertility, but it takes in water slowly and releases it slowly to plants. The claypan subsoil is more restrictive and more alkaline than the subsoil in the soils in capability unit IIIs-1. Salts are visible in most places at a depth of 15 to 20 inches, and most areas have a water table at a depth of 3 to 7 feet. The surface layer is friable if undisturbed, but it tends to puddle and crust where cultivated.

Wheat, oats, barley, rye, alfalfa, and tame grasses are suitable crops. Winter wheat and alfalfa are the main crops. In some areas producing alfalfa seed is profitable. Row crops are not suitable. Many areas are still in native grass and are used for grazing and hay.

Improving tilth, maintaining content of organic matter, and loosening the claypan are the main management concerns on this soil. Soil blowing is a secondary concern. Use of grasses and legumes in the cropping system and effective use of crop residue help to improve tilth and to increase intake of moisture. These practices also help to control erosion. Stubble mulching is desirable when grain crops that produce much residue are grown.

CAPABILITY UNIT Vw-1

This unit consists of deep, dark-colored, loamy soils that have a high water table. These soils are in the Gannett, Lamo, and Loup series. They are nearly level and occur in basins and valleys, mainly in and near the sandhills. The water table is at or near the surface early in the growing season. In Gannett soils, it generally remains there during most of the growing season and seldom drops to a depth below 2 feet. In the Lamo and Loup soils, the water table seldom drops to a depth below 4 feet.

Because artificial drainage generally is not practical, the soils of this unit probably are best suited to hay, pasture, and wildlife. Most areas are used for hay, which has good growth. Some areas of Gannett soils, however, have been artificially drained so as to permit use for hay. Proper range use helps maintain stands of tall grasses. Springs, wells, and dugouts are sources of water for livestock.

CAPABILITY UNIT VIe-1

This unit consists of moderately deep and deep soils on uplands that are too erodible for use as croplands. They should be cultivated only long enough to establish trees or to reestablish grasses. These soils are in the Anselmo, Holt, Kadoka, Oglala, and Vetal series.

Most areas are in native grasses and are used for grazing and hay. Proper range use helps to control erosion and to conserve moisture. Contour furrows help to slow runoff and to restore the grass cover on pastures that are in poor or fair range condition. Water for livestock is obtained mainly from wells and springs. Stockwater dams and dugouts are feasible in some places, but in many places the underlying materials are so porous that these structures do not hold water satisfactorily.

CAPABILITY UNIT VIe-2

This unit consists of deep, undulating to rolling, sandy soils on uplands in the southern and eastern parts of the county. These soils are too sandy and erodible for cultivation. They are Bankard, Dunday, and Valentine soils, and some areas are Blown-out land.

Almost all areas are in native grasses. Management is needed that helps to control soil blowing and sand blowouts. Proper range use helps to control soil blowing. Sand blowouts can be restored to native grasses if practices are used to stabilize dunes. Shallow wells provide water for livestock.

CAPABILITY UNIT VIw-1

This unit consists of Alluvial land that is subject to overflow. This land is mostly in bottom-land areas that are narrow and are cut into small parcels by meandering channels. Most areas have a water table at only a moderate depth, but in places it rises so high early in the growing season that cultivation is not practical. Flooding damages this land mainly by depositing debris.

Most areas are in native grasses and are used for grazing and hay. Scattered clumps of native trees and shrubs provide habitat for wildlife. A few small tracts are in alfalfa. Small areas along some streams are used as family garden plots.

Proper range use on this land and adequate conservation measures on the adjacent watershed help to slow runoff and to lessen damage by flooding. Structures that retard water and stabilize the grade help to control flooding in some areas.

CAPABILITY UNIT VIs-1

This unit consists of soils that have a thin surface layer, and a very hard and very firm claypan subsoil that is moderately alkaline to strongly alkaline. These soils are in the Hoven and Minatare series.

The soils in this unit have poor tilth and very slow permeability. Water ponds on the Hoven soil. The Minatare soils have a fluctuating water table that raises salts to within 10 inches of the surface. In the spring both kinds of soils are slow to dry.

About 50 percent of the acreage of the Hoven soil is cultivated. Most areas of the Minatare soils are in native grasses and are used for grazing.

The main concern of management on these soils is keeping an adequate plant cover. Proper range use helps to maintain the grass cover. Grazing should be avoided in spring and early in summer when these soils are wet. Suitable grasses should be interseeded on pasture in poor or fair condition.

CAPABILITY UNIT VIs-2

In this unit are shallow, gently sloping to moderately steep, sandy, loamy, and silty soils of the uplands. These soils are too shallow for cultivation, and they erode easily if the plant cover is disturbed. The soils in this unit are in the Canyon, Epping, and Tassel series.

Management is needed that controls erosion and conserves moisture. Proper range use helps to control erosion and to conserve moisture on areas in native grasses. Contour furrowing and range seeding can be used as needed on most areas. Cropland should be seeded to native grasses. Wells and springs provide water for livestock. In many areas the underlying materials are too porous to hold water, and these areas are not suitable for dams and dugouts.

CAPABILITY UNIT VIIe-1

The only soil in this unit is Valentine fine sand, hilly. This soil has slopes that are steeper and more irregular than those of the sandy soils in capability unit VIe-2. It blows easily.

The main management concern is maintaining adequate plant cover so as to control soil blowing and prevent the forming of barren sand dunes and blowouts. Most mechanical practices are impractical on this choppy, hilly soil. Erosion is controlled by proper range use. Grazing should be deferred where range is in poor or fair condition. Blowouts should be seeded by hand, mulched with hay, and fenced from the surrounding range.

CAPABILITY UNIT VIIs-1

This unit consists of shallow soils that generally are hilly and occur on uplands where outcrops of sandstone and siltstone are common. In some places the Canyon soils are intermingled with outcrops of rock. These soils are in the Canyon and Tassel series. Gravelly land also is in this unit.

On the soils of this unit, management is needed that maintains adequate plant cover and helps to control erosion. Proper range use is the most practical way to control erosion. Grazing should be deferred where range condition is poor or fair. Because the soils in this unit are shallow and have steep, irregular slopes, mechanical practices and treatment are not practical. Food and cover are provided for game animals by scattered pines on some steep slopes and by deciduous trees and shrubs at the bottom of ravines.

CAPABILITY UNIT VIIIw-1

This capability unit consists only of Marsh. Coarse aquatic plants grow in areas of Marsh, which are interspersed with small bodies of water. This land type is used mostly as habitat for waterfowl and for beaver, mink, and muskrat. Deer and other wildlife frequent areas of Marsh.

CAPABILITY UNIT VIIIs-1

Only Rock outcrop, in Canyon-Rock outcrop complex and in Canyon complex, 18 to 40 percent slopes, occurs in this capability unit. The outcrops support little or no vegetation, though stunted pines grow in places. This land type is valuable mainly as scenery.

Predicted Yields

Progressive farmers in Bennett County have sought and recently have practiced better methods of managing soils. As a result, the county produces high yields of winter wheat. The use of summer fallow was one of the first practices of management that was accepted in the county. Acceptance of stubble-mulch tillage has been slower, but stubble-mulch tillage is on the way of becoming a common practice. Use of chemicals in controlling insects and noxious weeds is more common each year. Terraces for erosion control are gradually appearing on the landscape. Table 2 lists average yields of winter wheat, barley, oats, corn, and alfalfa that can be expected on the soils of Bennett County. The predictions are for dryfarmed soils under two levels of management.

The yields shown in columns A are those that can be expected under management that is commonly practiced in the county. In this management, (1) winter wheat alternated with summer fallow is the common practice; (2) some spring-sown small grains, corn, and sorghums are grown as feed for livestock; (3) alfalfa and tame grasses also are grown, but they generally remain in a field until the stand fails or becomes unproductive; (4) crop residue is used but not in sufficient quantity; (5) weeds are controlled, but the number of tillage operations required causes the soil structure to deteriorate and a tillage pan to form; (6) fallow fields are bare in summer until winter wheat is seeded; (7) water erosion and soil blowing cause loss of soil in some years; and (8) commercial fertilizer, manure, and green-manure crops generally are not used.

The predicted yields shown in columns B are those that can be expected under improved management. This management includes (1) using a cropping system that supplies organic matter and helps to maintain fertility and good tilth; (2) using practices that keep erosion at a minimum and that conserve moisture by using a combination of practices; (3) adding commercial fertilizer in amounts indicated by soil tests and field trials; (4) tilling at the right time and only enough to control weeds; and (5) planting adapted crop varieties.

Use of the Soils for Windbreaks[5]

In Bennett County, ponderosa pine in thin stands, occasional clumps, and single trees is scattered throughout the Oglala-Canyon association (fig. 19). Along large streams in the county are boxelder, green ash, American elm, and cottonwood. Shrubs, such as chokecherry, plum, juneberry, and woods rose, are on some stream bottoms and along ravines in the hilly parts of the county. Some of the native trees are cut for fuelwood and fenceposts. Few are used for rough lumber because the trees are limby,

[5] By ELMER L. WORTHINGTON, woodland conservationist, Soil Conservation Service.

TABLE 2.—*Predicted average acre yields of principal dryfarmed crops under two levels of management*

[Yields in columns A are those to be expected under management commonly practiced; yields in columns B are those to be expected under improved management. Only soils suitable for crops are listed. Absence of yield figure indicates that crop commonly is not grown on that soil]

Soil	Winter wheat [1]		Barley		Oats		Corn		Alfalfa	
	A	B	A	B	A	B	A	B	A	B
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*
Altvan loam, 0 to 5 percent slopes	21	27	17	21	18	29	------	------	0. 7	1. 2
Anselmo fine sandy loam, 0 to 5 percent slopes	19	25	17	21	23	30	25	31	1. 1	1. 6
Bankard loamy fine sand	------	------	12	15	15	19	15	20	. 9	1. 4
Dawes-Keith complex, 0 to 3 percent slopes:										
Dawes soil	25	29	20	24	26	32	------	------	. 9	1. 3
Keith soil	34	41	26	32	35	45	25	33	1. 3	1. 6
Dunday loamy fine sand, 0 to 6 percent slopes	------	------	14	18	15	21	17	24	. 9	1. 4
Dunday-Anselmo complex, 0 to 3 percent slopes:										
Dunday soil	------	------	14	18	15	21	17	24	. 9	1. 4
Anselmo soil	19	25	17	21	23	30	25	31	1. 1	1. 6
Dunday-Anselmo complex, 3 to 9 percent slopes:										
Dunday soil	------	------	------	------	------	------	------	------	------	------
Anselmo soil	18	23	15	19	21	28	22	28	. 9	1. 3
Dunday and Elsmere loamy fine sands (0 to 3 percent slopes):										
Dunday soil	------	------	14	18	15	21	17	24	. 9	1. 4
Elsmere soil	------	------	------	------	16	23	20	26	1. 7	2. 5
Dunday-Valentine complex, 0 to 5 percent slopes:										
Dunday soil	------	------	14	18	15	21	17	24	. 9	1. 4
Valentine soil	------	------	------	------	------	------	------	------	------	------
Goshen silt loam, 0 to 3 percent slopes	35	42	30	37	38	48	26	35	1. 5	2. 2
Goshen silt loam, 3 to 6 percent slopes	34	41	29	36	37	46	25	34	1. 4	2. 1
Haverson loam, 0 to 3 percent slopes	17	26	15	19	24	34	15	26	1. 3	1. 8
Holt and Tuthill fine sandy loams, 0 to 5 percent slopes:										
Holt soil	21	26	16	22	20	28	24	31	. 9	1. 3
Tuthill soil	23	30	19	25	24	32	27	34	1. 1	1. 6
Holt and Tuthill fine sandy loams, 5 to 9 percent slopes:										
Holt soil	18	23	15	19	18	24	21	27	. 7	1. 0
Tuthill soil	21	27	18	23	23	30	24	30	1. 0	1. 4
Kadoka silt loam, 3 to 5 percent slopes	24	30	20	25	26	32	------	------	. 9	1. 1
Keith silt loam, 0 to 3 percent slopes	34	41	26	32	35	45	25	33	1. 3	1. 6
Keith silt loam, 3 to 5 percent slopes	32	38	25	31	32	41	22	28	1. 2	1. 5
Keith-Colby silt loams, 9 to 12 percent slopes:										
Keith soil	26	31	19	24	22	29	------	------	. 9	1. 2
Colby soil	18	24	15	20	17	23	------	------	. 7	. 9
Keith-Rosebud silt loams, 0 to 2 percent slopes	32	39	25	31	33	43	23	30	1. 2	1. 5
Keith-Rosebud silt loams, 2 to 6 percent slopes	30	37	24	30	31	39	21	26	1. 1	1. 4
Keith and Ulysses silt loams, 5 to 9 percent slopes	29	35	22	28	28	36	19	24	1. 0	1. 3
Mosher-Minatare complex (0 to 6 percent slopes):										
Mosher soil	15	19	15	18	18	24	------	------	1. 0	1. 3
Minatare soil	------	------	------	------	------	------	------	------	------	------
Oglala-Rosebud silt loams, 0 to 3 percent slopes	30	36	23	30	30	40	21	29	1. 1	1. 5
Oglala-Rosebud silt loams, 3 to 6 percent slopes	27	33	22	28	28	36	19	25	1. 0	1. 4
Richfield and Keith silt loams, 0 to 2 percent slopes	33	41	25	32	34	45	23	30	1. 2	1. 6
Richfield and Keith silt loams, 2 to 6 percent slopes	31	37	24	30	30	40	20	26	1. 1	1. 5
Tuthill and Anselmo fine sandy loams, 0 to 5 percent slopes:										
Tuthill soil	23	30	19	25	24	32	27	34	1. 1	1. 6
Anselmo soil	19	25	17	21	23	30	25	31	1. 1	1. 6
Tuthill and Anselmo fine sandy loams, 5 to 9 percent slopes:										
Tuthill soil	21	27	18	23	23	30	24	30	1. 0	1. 4
Anselmo soil	18	23	15	19	21	28	22	28	. 9	1. 3
Vetal and Goshen soils, 0 to 3 percent slopes:										
Vetal soil	21	27	19	24	24	32	27	34	1. 2	1. 6
Goshen soil	35	42	30	37	38	48	26	35	1. 5	2. 2
Vetal-Holt fine sandy loams, 6 to 15 percent slopes	------	------	15	19	18	24	------	------	. 8	1. 0

[1] Yields are for wheat following summer fallow.

Figure 19.—Scattered ponderosa pine on Oglala-Canyon complex, 9 to 18 percent slopes.

crooked, and in poor general condition. The main value of native shrubs and trees in the county is as protection for livestock in winter and as food and cover for birds and other wildlife.

Few farmsteads in the county have natural windbreaks that are completely effective. Most windbreaks around farmsteads and ranch headquarters need supplemental plantings to have good, year-round windbreaks that keep snow drifts from the yards and provide protection for livestock, fruit trees, and gardens.

Field windbreaks protect cropland from soil blowing and hold snow on the fields. On the Keith-Rosebud association, where most of the cropland in Bennett County occurs, one-row field windbreaks are effective. Wider field windbreaks are especially effective on cultivated areas of the Anselmo, Dunday, Elsmere, and Tuthill soils.

On rangeland, trees for windbreaks are planted in winter feeding areas to protect livestock (fig. 20). The South Dakota Department of Fish, Game, and Parks has established several game habitat plantings in the county. These windbreaks are designed to provide winter cover and food for game birds.

Sites for windbreak plantings need careful preparation, and the trees planted need protection from fire, insects, disease, and excessive grazing. Information about the establishment and care of trees can be obtained from the local offices of the Soil Conservation Service or from the Bureau of Indian Affairs.

Some species of trees and shrubs grow well only on certain soils, and a few grow well on many soils. The soils in Bennett County that are suitable for tree planting are placed in six windbreak suitability groups, which are described in the following paragraphs. The names of the soil series represented in each group are mentioned in the description of the group, but this does not mean that all soils in the series are in the group. To find the windbreak group for any mapping unit, refer to the "Guide to Mapping Units."

WINDBREAK SUITABILITY GROUP 1

In this windbreak suitability group are deep and moderately deep, loamy and sandy soils on uplands and deep, sandy soils on bottom lands. These soils are in the Anselmo, Bankard, Dunday, Holt, Tuthill, and Vetal series. Most of them are well drained. They take in water readily and release it readily to tree roots. In places tree roots reach the shallow water table that occurs at a depth of 10 to 30 feet. These soils are good for tree growth, but soil blowing is a hazard. Stubble or other vegetation should be left between the rows of trees to control blowing, and cultivation should be confined to the tree rows.

Broad-leaved trees suitable for the soils in this windbreak suitability group are American elm, Siberian elm, Chinkota elm, crabapple, green ash, hackberry, Harbin pear, and honeylocust. Hackberry should be used sparingly because this tree has low resistance to drought.

Suitable conifer trees for these soils are eastern redcedar, Rocky Mountain redcedar, and ponderosa pine. Suitable shrubs are American plum, buffaloberry, caragana, chokecherry, common lilac, cotoneaster, honeysuckle, Russian-olive, sand cherry, and three-leaf sumac.

WINDBREAK SUITABILITY GROUP 2

This windbreak suitability group consists of deep and moderately deep, silty and loamy soils that have moderately slow to moderately rapid permeability. These soils are in the Altvan, Colby, Goshen, Haverson, Kadoka, Keith, Oglala, Richfield, Rosebud, and Ulysses series. They are moderately well drained and well drained. The Haverson soils are occasionally flooded by streams and, in places,

Figure 20.—Windbreak of cedar and ponderosa pine on Valentine soils, near basin in Loup soil that provides hay for winter feeding.

have a water table at a depth of about 20 feet. Goshen soils receive some runoff from adjacent slopes. All other soils in this group depend mostly on precipitation for moisture.

These soils are good for windbreaks. Contour plantings and terraces help to conserve moisture and to control erosion in sloping areas. Clean cultivation between the tree rows during the first few years of growth helps to eliminate weeds, which compete with the trees for moisture.

Trees suitable for the soils in this windbreak suitability group are boxelder, Siberian elm, Chinkota elm, crabapple, green ash, hackberry, honeylocust, eastern redcedar, Rocky Mountain redcedar, ponderosa pine, Black Hills spruce, and Colorado blue spruce. Cottonwood, golden willow, and white willow can be used on Haverson soils. Hackberry trees should be used sparingly because they have low resistance to drought. Special management is needed in order to establish spruce trees.

Suitable shrubs are American plum, buffaloberry, caragana, cotoneaster, chokecherry, common lilac, honeysuckle, Nanking cherry, Russian-olive, sand cherry, and three-leaf sumac.

WINDBREAK SUITABILITY GROUP 3

This windbreak suitability group consists of somewhat poorly drained to poorly drained, mixed alluvial soil materials and sandy to loamy soils that occupy bottom lands and subirrigated basins and valleys. These soils are in the Elsmere, Gannett, Lamo, and Loup series, and in places there is Alluvial land. They have a water table that fluctuates and limits the kinds of trees that can be grown.

Suitable trees for windbreaks on these soils are cottonwood, golden willow, white willow, ponderosa pine, Black Hills spruce, and Colorado blue spruce. Except on wetter areas, other trees suitable for windbreaks are boxelder, Chinkota elm, Siberian elm, crabapple, green ash, hackberry, honeylocust, eastern redcedar, and Rocky Mountain redcedar. Suitable shrubs are American plum, buffaloberry, caragana, chokecherry, cotoneaster, honeysuckle, lilac, Nanking cherry, and Russian-olive.

WINDBREAK SUITABILITY GROUP 4

In this windbreak suitability group are deep soils that have a moderately thick and thick, friable silt loam surface layer and a claypan subsoil. The claypan subsoil restricts the movement of water in the soils and affects the root development of young trees. These soils are in the Dawes and Mosher series.

Trees suitable for windbreaks are Siberian elm, Chinkota elm, green ash, Harbin pear, eastern redcedar, Rocky Mountain redcedar, and ponderosa pine. Suitable shrubs are buffaloberry, caragana, common lilac, Russian-olive, and three-leaf sumac.

WINDBREAK SUITABILITY GROUP 5

This windbreak suitability group consists of saline-alkali soils that are moderately wet because they have a high water table. Permeability is very slow, and salts are within a foot of the surface. These soils are in the Minatare series.

Trees suitable for windbreaks are cottonwood, diamond willow, and purple willow. On the drier sites, Siberian elm, Chinkota elm, green ash, and honeylocust have some chance of growth on these soils. Suggested shrubs are buffaloberry, Russian-olive, and three-leaf sumac.

WINDBREAK SUITABILITY GROUP 6

In this windbreak suitability group are deep, hilly and rolling, loose, sandy soils of the Valentine series and Blown-out land on uplands. Water enters these soils easily and passes rapidly to the water table below. Because these soils blow easily, their grass cover should not be disturbed. Where windbreaks are desired for protection of winter feedlots and ranch headquarters, trees should be planted in shallow furrows and not cultivated.

Suitable trees for windbreaks are eastern redcedar, Rocky Mountain redcedar, and ponderosa pine. Trees and shrubs that can be grown under intensive management are Siberian elm, green ash, Russian-olive, American plum, and common lilac.

Condition and height of woodland species by windbreak suitability groups

Table 3 shows the estimated condition and height of specified trees and shrubs at 20 years of age for the six windbreak suitability groups in the county. Some of the estimated heights are based on actual measurements. The condition and the heights listed are for planted trees and shrubs that are managed carefully.

Condition is *good* if one or more of the following generally apply: (1) leaves (or needles) are normal in color and growth; (2) small amounts of deadwood are within the live crowns; (3) evidence of disease, insect, and climatic damage is limited; and (4) only slight evidence of suppression or stagnation.

Condition is *fair* if one or more of the following generally apply: (1) leaves (or needles) are obviously abnormal in color and growth; (2) substantial amounts of deadwood are within the live crowns; (3) evidence of moderate disease, insect, or climatic damage is obvious; (4) definite suppression or stagnation exists; and (5) growth during current year is less than normal.

Condition is *poor* if one or more of the following generally apply: (1) leaves (or needles) are very abnormal in color and growth; (2) very large amounts of deadwood are within the live crowns; (3) evidence of extensive disease, insect, and climatic damage is obvious; (4) severe stagnation, suppression, or decadence is present; and (5) growth during current year is negligible.

Managing Soils for Wildlife[6]

The distribution and abundance of wildlife species are determined by the occurrence of suitable habitat. Suitable habitat, in turn, depends on the kinds of soils, topography, climate, and whether the soils are primarily used to produce farm crops, woodland products, or forage for livestock.

A convenient way of discussing the suitability of the soils in this county for wildlife is by wildlife suitability groups that are based on soil associations. These wildlife groups provide information on the distribution of wildlife species and their habitat. This information is useful in broad planning of land use, and it also serves as a guide in the acquisition of land for wildlife programs.

The six associations in the county are placed in five wildlife suitability groups. These associations are shown on the general soil map at the back of this survey and are described in the section "General Soil Map." The wildlife suitability groups are discussed in the following paragraphs.

WILDLIFE SUITABILITY GROUP 1

This wildlife suitability group consists of rolling to hilly, sandy soils in the Valentine soil association. Almost all of this soil association is in native vegetation, and less than 1 percent is cropland.

Game that lives on this group of soils consists of sharp-tailed grouse, mule deer, white-tailed deer, antelope, mourning dove, and waterfowl. The soils in this group probably are most suitable for supporting sharp-tailed grouse and waterfowl than other kinds of wildlife. Spring-fed marshes and sandhill lakes that provide permanent water are excellent areas for the nesting of ducks and the raising of their broods if the vegetation is not excessively grazed and is in adequate amounts. Proper use of rangeland in this wildlife group benefits the sharp-tailed grouse, deer, and antelope. Scalp planting of pine and juniper on grasslands will provide roosting cover for grouse. In scalp planting the grass is scalped off, and the trees are planted without cultivation.

WILDLIFE SUITABILITY GROUP 2

This wildlife suitability group consists of the gently sloping to hilly, loamy and sandy soils in the Anselmo soil association. Most of this association is in native vegetation, and only about 10 percent is cultivated.

Sharp-tailed grouse, pheasant, and deer live on this wildlife group. The soils in this group probably are most suitable for producing sharp-tailed grouse and pheasant, but these birds are not abundant, because trees are limited to only a few plantings. Sharp-tailed grouse and pheasant can be increased by additional plantings for farmstead and feedlot windbreaks, for field windbreaks, or specifically for game cover.

WILDLIFE SUITABILITY GROUP 3

This group consists of gently sloping, silty and loamy soils in the Keith-Rosebud soil association. About 85 percent of this soil association is cultivated.

The game that occurs in this group includes pheasant, sharp-tailed grouse, and deer. The soils in this group probably are most suitable for pheasant, and these birds have built moderately large populations where food is readily available and good cover is fairly well distributed. Naturally occurring woody cover is lacking, but most farmsteads have windbreak plantings, and there are a few field windbreaks. Several habitat plantings for game were made in Bennett County late in the 1950's (fig. 21). Tree plantings provide most of the winter cover for pheasant, but frequent moderate to high mortality in winter indicates that this cover is not adequate in many places. The number of pheasants could be increased by using sod waterways, field windbreaks, and other means to control erosion.

[6] By JOHN FARLEY, biologist, Soil Conservation Service.

TABLE 3.—*Estimated condition and height of woodland species at 20 years of age by windbreak suitabil*

[For definitions of condition classes, see text. Estimates of height not given for species rated poor]

Woodland species	Group 1		Group 2		Group 3		Group 4		Group
	Condition	Height	Condition	Height	Condition	Height	Condition	Height	Condition
		Feet		*Feet*		*Feet*		*Feet*	
American plum	Good	5–6	Good	7–8	Fair	4–5	Poor		Poor
Black hills and Colorado blue spruce.	Poor		Fair	17–19	Good	18–20	Poor		Poor
Boxelder	Poor		Fair	15–17	Fair	14–16	Poor		Poor
Buffaloberry	Fair	5–6	Fair	5–7	Fair	5–7	Fair	3–4	Fair
Caragana	Good	8–10	Good	8–9	Good	7–9	Fair	3–4	Poor
Chokecherry	Fair	8–11	Good	8–11	Good	8–10	Poor		Poor
Cotoneaster	Good	4–5	Good	4–5	Good	4–5	Poor		Poor
Cottonwood	Poor		Poor		Fair	28–30	Poor		Fair
Crabapple	Fair	11–13	Good	11–13	Fair	11–13	Poor		Poor
Eastern and Rocky Mountain redcedars.	Good	11–13	Good	10–12	Good	12–14	Fair	5–7	Poor
Green ash	Good	14–16	Good	14–16	Good	16–18	Fair	9–11	Fair
Hackberry	Good	16–18	Good	12–14	Good	12–14	Poor		Poor
Harbin pear	Good	11–13	Good	11–13	Good	10–12	Fair	4–6	Poor
Honeylocust	Fair	20–22	Fair	18–20	Good	20–22	Poor		Fair
Honeysuckle	Fair	4–6	Good	6–8	Fair	5–7	Poor		Poor
Lilac	Good	4 5	Good	6–7	Fair	4–5	Fair	3–4	Poor
Nanking cherry	Poor		Fair	4–5	Fair	4–5	Poor		Poor
Ponderosa pine	Good	18–20	Good	18–20	Good	16–18	Fair	9–11	Poor
Russian-olive	Fair	15–17	Fair	15 17	Fair	12–14	Fair	8–9	Fair
Siberian and Chinkota elms	Good	22–24	Good	24–26	Good	23–27	Fair	10–12	Fair
White and golden willow	Poor		Poor		Good	24–26	Poor		Fair

Figure 21.—**Plantings for game habitat on Keith-Rosebud soil association.**

WILDLIFE SUITABILITY GROUP 4

This wildlife suitability group consists of rolling to hilly, loamy and silty soils in the Oglala-Canyon and the Kadoka-Epping soil associations. Scattered ponderosa pine trees are on the ridges and side slopes in some of the hilly areas. The bottoms of some ravines are naturally wooded with thickets of deciduous trees and shrubs. The soils of this group are mostly in native grasses, but the more gently sloping soils have scattered tracts of cropland that make up about 10 percent of the wildlife group.

The game in this group includes mule deer, white-tailed deer, antelope, sharp-tailed grouse, pinnated grouse, and pheasant. Mule deer and sharp-tailed grouse have the highest potential in this wildlife suitability group. Moderate populations of pheasants occur where grain farming is associated with favorable nesting and other habitat requirements.

Bass-bluegill fisheries have been developed where stockwater dams are of adequate size and height. These constructed ponds also produce puddle duck species in good amounts.

WILDLIFE SUITABILITY GROUP 5

This wildlife suitability group consists of nearly level, alluvial soils that have a claypan subsoil and a moderately high water table. Most of these soils are in the Mosher-Minatare-Loup soil association, but small areas occur in the Valentine soil association. These soils are mostly in native vegetation used for hay meadows and grazing. Cropland makes up less than 10 percent of the acreage and consists mainly of the better drained soils.

This group is more productive of a greater variety of wildlife than any other suitability group in the county. In this group are ducks and shore birds, mule and white-tailed deer, furbearers, pheasant, grouse, and mourning dove.

The LaCreek Migratory Waterfowl Refuge, managed primarily for migrating waterfowl, is in this wildlife group. The refuge contains 9,400 acres, about 5,000 of which is prime marshland. The better drained areas of the refuge are farmed to provide food for ducks and geese, deer, and upland game birds.

Areas along the Little White River and LaCreek Lake for years have produced economically significant fur crops from beaver, mink, and muskrat. Also, a considerable amount of meat has been harvested from the snapping turtles that inhabit marsh and water areas in this suitability group. The life history of this animal is being studied by the refuge personnel of the United States Fish and Wildlife Service in cooperation with South Dakota State University.

In this suitability group, several areas adjacent to the sandhills contain cool, fresh-water springs. Ponds fed by these springs are suitable for raising trout. Other fisheries in this wildlife suitability group are in the waters of the LaCreek Refuge.

Engineering Uses of Soils [7]

Soils are used in engineering primarily as structural material or as foundation material upon which structures are built. Some of the structures for which soil materials

[7] Prepared by ODELL A. ALDRICH, agricultural engineer, Soil Conservation Service.

are used are roads and airports, building foundations, pipelines, drainage systems, and irrigation systems. Among the soil properties most important in engineering are permeability, shear strength, shrink-swell potential, water-holding capacity, grain size distribution, plasticity, and reaction.

Most of the information in this section is in tables 4, 5, 6, and 7, but additional information useful to engineers is in other sections of this soil survey, particularly "Descriptions of the Soils" and "Formation and Classification of the Soils."

Some of the terms used by the soil scientists may be familiar to the engineer, and some terms may have a special meaning in soil science. Several of these terms are defined in the Glossary at the back of this survey.

The engineering interpretations reported here can be used for many purposes. It should be emphasized, however, that these interpretations may not eliminate the need for sampling and testing at the site of specific engineering works involving heavy loads and where the excavations are deeper than the depths of the layers here reported. Even in these situations, the soil map is useful for planning more detailed field investigations and for suggesting the kinds of problems that may be expected.

The estimates and interpretations given in this section for the soils in Bennett County can be used to—

1. Make preliminary estimates of the engineering properties of soils that affect the planning of farm ponds, irrigation systems, water spreading systems, diversions, terraces, and other earthen structures for farms and ranches.
2. Make preliminary evaluations of soil and ground conditions that will aid in selecting locations for highways, airports, pipelines, and cables, and in planning detailed investigations at the selected locations.
3. Locate probable sources of sand, gravel, clay, or rock suitable for use in construction.
4. Aid in selecting and developing industrial, business, residential, and recreational sites.
5. Supplement the information obtained from other published maps, reports, and aerial photographs for the purpose of preparing maps and reports that can be used readily by engineers.
6. Develop other preliminary estimates that are pertinent to specific construction purposes in Bennett County.

Engineering classification systems

The engineering systems now most widely used to classify soils are the Unified system (*21*), and the system developed by the American Association of State Highway Officials (AASHO) (*1*).

The Unified system, established by the Waterways Experiment Station, Corps of Engineers, is based on the identification of soils according to particle-size distribuion, plasticity, and liquid limit. In this system SW and SP are symbols for clean sands; SM and SC, for sands with nonplastic or plastic fines (G replaces S if the major coarse fraction is gravel); ML and CL, for nonplastic or plastic fine-grained materials having a low liquid limit; and MH and CH, for nonplastic or plastic fine-grained materials having a high liquid limit.

In the AASHO system, classification is based on the performance of soils in highways as indicated by soil properties important in engineering. This system groups soils of about the same general capacity for load carrying and service into seven basic groups, A-1 through A-7. The best soils for road subgrade are classified A-1; the poorest, A-7.

Agricultural scientists classify soils by using the textural classification of the U.S. Department of Agriculture. In this system the classification is determined mainly by the percentage of soil particles smaller than 2 millimeters in diameter, or the percentage of sand, silt, and clay.

Estimated properties of the soils

Table 4 lists the soil series and mapping units in Bennett County and gives estimates of some of the soil properties that affect engineering work. These estimates are based on the engineering test data shown in table 6 and on knowledge of the soils gained during the course of the soil survey. A more complete description of each soil is given in the section "Descriptions of the Soils."

The estimated percentage of material passing the number 10, 40, and 200 sieves reflects the normal range for the soils of a specified series. Most soils of the series fall within the ranges listed in table 4, but it should not be assumed that all the soils of the series throughout the county fall within the ranges shown or that in all places engineering classification is as shown in table 4.

Permeabiilty relates only to the movement of water downward through undisturbed soil material. The estimates shown are based on soil structure and texture, test data, and experience on similar soils.

Available water-holding capacity is the amount of water held in the soil for use by plants after the free water has drained out.

Reaction, which indicates the degree of acidity or alkalinity of a soil, is expressed in terms of pH value. The estimates are based on actual test data for similar soils that were obtained by using the glass electrode or the color indicator test.

Shrink-swell potential indicates the change in volume of a soil to be expected from a change in moisture content.

The few soils in Bennett County that are affected by salinity or by dispersion are designated by footnotes in table 4. Salinity is the content of soluble salts. In a dispersed soil, structure is destroyed because each soil particle behaves as an aggregate. Also given in footnotes are the depth to the water table for those soils affected by a high water table.

Engineering interpretations of soil properties

In table 5 the soils of the county are rated according to their suitability as sources of topsoil and road fill and according to their limitations for sewage disposal. Also given in table 5 are soil features that affect suitability as sites for highways, farm ponds, terraces and diversions, and foundations for low buildings. In naming features affecting the foundations of low buildings, the ratings of "poor," "fair," and "good" are listed for bearing capacity, but these ratings should not be given a specific value in pounds per square foot.

TABLE 4.—*Estimated*

[Estimates are not shown for Alluvial land (Aa), Blown-out land

Soil series and map symbols	Depth to bedrock	Depth from surface	Classification	
			USDA texture	Unified
	Feet	*Inches*		
Altvan: A1B	>5	0-10	Loam	ML
		10-27	Clay loam to sandy clay loam	SC to CL
		27-50	Stratified gravelly sandy loam to gravel	SM to GM
Anselmo: AnB, AtE (For properties of Tassel soil in AtE, refer to Tassel series.)	>5	0-15	Fine sandy loam	SM
		15-60	Sandy loam to sand	SM to SM-SC
Bankard: Bk	>10	0-9	Loamy fine sandy to fine sandy loam	SM
		9-60	Stratified loamy fine sand to sand	SM
Canyon: CnF, CoF, Cr, CyD2 (For properties of Oglala soil in CoF and of Rosebud soil in CyD2, refer to the Oglala and Rosebud series, respectively.)	½-1½	0-8	Loam	ML
		8	Weakly cemented sandstone.	
Colby (Mapped only with soils of Keith series.)	>5	0-60	Silt loam to very fine sandy loam	ML
Dawes: DkA [1], DrB [1] (For properties of Keith soil in DkA and of Richfield soil in DrB, refer to the Keith and Richfield series, respectively.)	>10	0-11	Silt loam to loam	ML-CL
		11-22	Clay loam to clay	CL to CH
		22-60	Silt loam to loam	ML-CL to ML
Dunday: DsB, DtA, DtC, Du, DvB (For properties of Anselmo soil in DtA and DtC, of Elsmere soil in Du, and of Valentine soil in DvB, refer to the Anselmo, Elsmere, and Valentine series, respectively.)	>10	0-60	Loamy fine sand to sand	SM to SP-SM
Elsmere [2] (Mapped only with soils of Dunday series.)	>10	0-60	Loamy fine sand to sand	SM to SP-SM
Epping: EhF	½-1½	0-7	Silt loam	ML to ML CL
		7	Bedded siltstone and silt.	
Gannett: Ga [3,4]	>10	4-0	Peat	OL
		0-15	Fine sandy loam to loam	ML, SM
		15-60	Sand to sandy clay loam	SM to SC
Goshen: GoA, GoB	>5	0-7	Silt loam	ML to ML-CL
		7-49	Silty clay loam to clay loam	ML-CL to CH
		49-60	Silt loam to loam	ML-CL to ML
Haverson: HaA	>10	0-60	Stratified very fine sandy loam to silt loam.	ML
Holt: HtB, HtC (For properties of Tuthill soils, refer to Tuthill series.)	1½-3½	0-24	Fine sandy loam to sandy loam	SM-SC to SM
		24-60	Loamy very fine sand to very fine sand (unconsolidated sandstone).	SM
Hoven: Hv [5]	>5	0-5	Silt loam	ML to ML-CL
		5-25	Silty clay to silty clay loam	CH to MH
		25-55	Silty clay loam to silt loam	CH to ML-CL
		55	Bedded soft sandstone and loamy material.	
Kadoka: KaB	2-3½	0-6	Silt loam	ML to ML-CL
		6-18	Silty clay loam	CL to ML-CL
		18-30	Silt loam	ML-CL to ML
		30	Bedded siltstone and silt.	

See footnotes at end of table.

properties of the soils

(Bo), Gravelly land (Gr), Marsh (Ma), and Rock outcrop (in Cr)]

Classification—Continued	Percentage passing sieve—			Permeability	Available water-holding capacity	Reaction	Shrink-swell potential
AASHO	No. 10	No. 40	No. 200				
				Inches per hour	*Inches per inch of depth*	*pH*	
A-4	95–100	95–100	65–85	0. 8–2. 0	0. 17–0. 19	6. 6–7. 8	Low.
A-6 to A-7	85–100	85–100	45–75	0. 6–1. 5	0. 14–0. 21	7. 4–7. 8	Moderate.
A-2 to A-1, A-4	40–60	20–60	10–40	5. 0–10. 0	0. 03 0. 10	7. 4–8. 4	Low.
A-4 to A-2	95–100	80–100	25–40	2. 5–5. 0	0. 10–0. 15	6. 6–7. 3	Low.
A-2	95–100	60–85	15–35	2. 5–10. 0	0. 03–0. 15	6. 6–7. 8	Low.
A-4, A 2	95–100	40–80	20–40	2. 5–5. 0	0. 06–0. 15	6. 6–7. 8	Low.
A-2	90–100	35–75	10–35	5. 0–10. 0	0. 03–0. 10	7. 4–8. 4	Low.
A-4	90–100	40 95	50–70	1. 2–2. 5	0. 17–0. 19	7. 4–8. 4	Low.
A-4	100	100	80–100	0. 8–2. 0	0. 13–0. 19	7. 4–8. 4	Low.
A-4 to A-6	100	100	80–100	0. 8–2. 0	0. 17–0. 19	6. 6–7. 3	Low.
A-7 to A-6	100	100	80–100	0. 05–0. 2	0. 13–0. 21	7. 4–8. 4	High.
A-6 to A-4	90–100	90–100	55–90	0. 8–2. 0	0. 17–0. 19	7. 9–9. 0	Moderate to low.
A-2	100	70–100	10–35	5. 0–10. 0	0. 03–0. 10	6. 6–7. 8	Low.
A-2	100	60–90	10–35	5. 0–10. 0	0. 03–0. 10	6. 6–7. 8	Low.
A-4 to A-6	90–100	90–100	75–95	0. 8–2. 0	0. 17–0. 19	7. 9–8. 4	Low.
A-4, A-2	100	90–100	30–60	1. 2–5. 0	0. 10–0. 19	6. 6–7. 3	Low.
A-2	100	30–60	10–35	0. 8–10. 0	0. 03–0. 15	6. 6–7. 3	Low.
A-4 to A 7	100	100	85–100	0. 8–2. 0	0. 17–0. 19	6. 6–7. 3	Low to moderate.
A-7 to A-6	100	95–100	85–100	0. 2–2. 0	0. 14–0. 21	6. 6–7. 8	Moderate to high
A-6 to A-4	95–100	95–100	60–100	0. 8–2. 0	0. 17–0. 19	7. 9–8. 4	Low.
A-4	100	80–100	50–80	0. 8–2. 5	0. 13–0. 19	7. 4–8. 4	Low.
A-4, A-2	90–100	90–100	20–50	2. 5–5. 0	0. 10–0. 15	6. 6–7. 8	Low.
A-2	85–100	70–100	10–35	2. 5–10. 0	0. 06–0. 10	7. 9–8. 4	Low.
A-4 to A-6	100	100	85–100	0. 8–2. 0	0. 17–0. 19	6. 6–7. 3	Low.
A-7 to A-7	100	100	85–100	$<$0. 05	0. 13–0. 21	7. 4–8. 4	High.
A-6	95–100	95–100	75–100	0. 2–2. 0	0. 14–0. 21	7. 9–9. 0	Moderate to high.
A-4 to A-7	95–100	95–100	80–100	0. 8–2. 0	0. 17–0. 19	6. 6–7. 3	Low.
A-7	95–100	95–100	80–100	0. 2–2. 0	0. 14–0. 21	7. 4–8. 4	Moderate.
A-7 to A-6	80–100	80 100	75–95	0. 8–2. 0	0. 17–0. 19	7. 9–9. 0	Low.

TABLE 4.—*Estimated*

Soil series and map symbols	Depth to bedrock	Depth from surface	Classification: USDA texture	Classification: Unified
	Feet	*Inches*		
Keith: KeA, KeB, KhD, KrA, KrB, KuC (For properties of Colby soil in KhD, of Rosebud soils in KrA and KrB, and of Ulysses soil in KuC, refer to the Colby, Rosebud, and Ulysses series, respectively.)	>5	0-8	Silt loam	ML to ML-CL
		8-27	Silty clay loam to silt loam	CL to ML-CL
		27-60	Silt loam	ML-CL to ML
Lamo: La [6]	>10	0-36	Silt loam, loam, and clay loam	ML-CL to CL
		36-52	Loamy fine sand	SM
Loup: Lo [7]	>10	0-11	Fine sandy loam to loam	SM
		11-60	Fine sandy loam to fine sand	SM
Minatare: Me [5, 6]	>5	0-4	Loam to very fine sandy loam	ML
		4-19	Sandy clay loam to clay	CL to CH
		19-60	Very fine sandy loam to loam	ML to ML-CL
Mosher: Mm [5, 8] (For properties of Minatare soil, refer to Minatare series.)	>5	0-8	Silt loam to loam	ML-CL to ML
		8-16	Clay loam to clay	CL to CH
		16-55	Silty clay loam to loam	CL to ML
Oglala: OcE, OrA, OrB (For properties of Canyon soil in OcE and of Rosebud soils in OrA and OrB, refer to the Canyon and Rosebud series, respectively.)	3½-<5	0-32	Loam to silt loam	ML
		32-42	Loam to silt loam	ML to ML-CL
		42	Weakly cemented sandstone.	
Richfield: RkA, RkB (For properties of Keith soils, refer to Keith series.)	>5	0-9	Silt loam	ML-CL to ML
		9-24	Silty clay loam to clay loam	CL
		24-68	Silt loam	ML-CL to ML
Rosebud (Mapped only with soils of the Canyon, Keith, and Oglala series.)	1½-3½	0-8	Loam to silt loam	ML to ML-CL
		8-15	Loam to clay loam	ML-CL to CL
		15-28	Loam	ML to ML-CL
		28	Weakly cemented sandstone.	
Tassel: TaF (For properties of Anselmo soil, refer to Anselmo series.)	½-1½	0-11	Fine sandy loam to loamy sand	SM
		11	Weakly cemented sandstone.	
Tuthill: TnB, TnC (For properties of Anselmo soils, refer to Anselmo series.)	>4	0-9	Fine sandy loam	SM to ML
		9-29	Sandy clay loam to clay loam	CL
		29-60	Loamy sand to loam	SM to ML
Ulysses (Mapped only with soils of Keith series.)	>5	0-10	Silt loam	ML to ML-CL
		10-55	Silt loam to very fine sandy loam	ML to ML-CL
		55	Soft sandstone.	
Valentine: VaC, VaD, VeD (For properties of Tassel soil in VeD, refer to Tassel series.)	>10	0-60	Fine sand to loamy fine sand	SM to SP
Vetal: VgA, VnD (For properties of Goshen soil in VgA and of Holt soil in VhD, refer to the Goshen and Holt series, respectively.)	>10	0-42	Fine sandy loam to loamy very fine sand.	SM
		42-60	Very fine sandy loam to sand	ML to SM

1 Moderate dispersion.
2 Water table at 3 to 6 feet.
3 About 4 inches of peat on surface.
4 Water table at 0 to 20 inches.

properties of the soils—Continued

Classification—Continued	Percentage passing sieve—			Permeability	Available water-holding capacity	Reaction	Shrink-swell potential
AASHO	No. 10	No. 40	No. 200				
				Inches per hour	*Inches per inch of depth*	*pH*	
A-4 to A-7	100	95-100	70-95	0. 8-2. 0	0. 17-0. 19	6. 6-7. 3	Low.
A-7 to A-6	100	95-100	70-95	0. 2-1. 2	0. 14-0. 21	6. 6-7. 8	Moderate.
A-6 to A-4	95-100	95-100	60-95	0. 8-2. 0	0. 17-0. 19	7. 9-9. 0	Low.
A-6	100	100	70-95	0. 2-2. 0	0. 14-0. 21	7. 9-8. 4	Moderate.
A-4 to A-2	95-100	95-100	15-50	0. 8-10. 0	0. 06-0. 10	7. 9-8. 4	Low.
A-4 to A-2	100	70-95	30-50	1. 2-5. 0	0. 10-0. 19	7. 4-8. 4	Low.
A 2	100	50-90	15-35	2. 5-10. 0	0. 03-0. 15	6. 6-7. 3	Low.
A-4	100	95-100	50-85	1. 2 -2. 5	0. 13-0. 19	6. 6-7. 8	Low.
A-7	100	95-100	50-85	<0. 05-0. 2	0. 14-0. 21	8. 5-9. 5	High.
A-4 to A-6	95-100	90-100	50-85	1. 2 -2. 5	0. 13-0. 19	8. 5-9. 5	Moderate.
A-6 to A-4	100	95-100	60-85	0. 8 -2. 0	0. 17-0. 19	6. 6-7. 3	Moderate.
A-7	100	95-100	60-95	<0. 05-0. 2	0. 13-0. 21	7. 9-8. 4	High.
A-7-6 to A-4	90-100	90-100	50-90	0. 2 -2. 0	0. 14-0. 21	8. 5-9. 5	Moderate.
A-4	95-100	95-100	60-100	1. 2 -2. 5	0. 17-0. 19	6. 6-7. 8	Low.
A-4	90-100	90-100	60-100	1. 2 -2. 5	0. 17-0. 19	7. 9-8. 5	Moderate to low.
A-6 to A-4	100	90-100	85-100	0. 8 -2. 0	0. 17-0. 19	6. 0-7. 3	Low.
A-7 to A-6	100	90-100	85-100	0. 2 -0. 8	0. 14-0. 21	6. 6-7. 8	Moderate.
A-6 to A-4	95-100	95-100	70-100	0. 8 -2. 0	0. 17-0. 19	7. 9-8. 4	Low.
A-4	95-100	85-100	65-85	0. 8 -2. 5	0. 17-0. 19	6. 6-7. 8	Moderate.
A-6 to A-4	95-100	85-100	55-90	0. 2 -2. 5	0. 14-0. 21	7. 4-7. 8	Moderate.
A-4	85-100	80-95	50-75	1. 2 -2. 5	0. 17-0. 19	7. 9-8. 4	Low.
A-4 to A-2-4	80-100	70-95	30-50	2. 5 - 10. 0	0. 06-0. 15	7. 3-8. 4	Low.
A-4	100	90-100	40-60	2. 5 - 5. 0	0. 10-0. 15	6. 6-7. 3	Low.
A-6 to A-4	100	90-100	50-70	0. 8 - 2. 0	0. 14-0. 21	6. 6-7. 3	Moderate.
A-4 to A-2-4	90-100	50-85	15-60	1. 2 -10. 0	0. 03-0. 17	7. 4-8. 4	Low.
A-4 to A-6	100	95-100	70-100	0. 8 - 2. 0	0. 17-0. 19	6. 6-7. 8	Low to moderate.
A-4 to A-6	100	95-100	60-90	0. 8 - 3. 0	0. 13-0. 19	7. 9-8. 4	Low to moderate.
A-3 to A-1	100	40-100	0-30	5. 0 10. 0	0. 03 0. 10	6. 6-7. 3	Low.
A-4 to A-2-4	100	100	25-50	2. 5 - 5. 0	0. 10-0. 15	6. 6-7. 3	Low.
A-4 to A-2-4	95-100	85-100	15-55	2. 5 -10. 0	0. 06-0. 15	6. 6 -7. 8	Low.

[5] High dispersion, saline.
[6] Water table at 2 to 5 feet.
[7] Water table at 2 to 4 feet.
[8] Water table at 3 to 7 feet.

TABLE 5.—*Engineering*

[Interpretations are not shown for Alluvial land (Aa), Blown-out

Soil series and map symbols	Suitability as a source of—		Soil limitations for sewage disposal	
	Topsoil	Road fill	Septic tank filter fields	Lagoon
Altvan: AlB	Good	Fair to good	Slight	Severe: rapid permeability in substratum.
Anselmo: AnB, AtE (For interpretations of Tassel soil in AtE, refer to Tassel series.)	Fair: blows easily.	Good	Slight	Severe: rapid permeability in substratum.
Bankard: Bk	Poor: sandy; low organic matter.	Good	Moderate: occasional flooding.	Severe: rapid permeability.
Canyon: CnF, CoF, Cr, CyD2 (For interpretations of Oglala soil in CoF and of Rosebud soil in CyD2, refer to the Oglala and Rosebud series, respectively.)	Poor: thin	Fair	Moderate to severe: 3 to 40 percent slopes; soft, sandstone at depth of less than 24 inches.	Severe: 3 to 40 percent slopes.
Colby (Mapped only with soils of Keith series.)	Fair if fertilized; high content of lime.	Fair to poor	Moderate to severe: 9 to 12 percent slopes.	Moderate to severe: 9 to 12 percent slopes.
Dawes: DkA, DrB (For interpretations of Keith soil in DkA and of Richfield soil in DrB, refer to the Keith and Richfield series, respectively.)	Good	Poor	Moderate: moderately slow permeability.	Slight to moderate: unstable material.
Dunday: DsB, DtA, DtC, Du, DvB (For interpretations of Anselmo soil in DtA and DtC, of Elsmere soil in Du, and of Valentine soil in DvB, refer to the Anselmo, Elsmere, and Valentine series, respectively.)	Fair: blows easily.	Good	Slight	Severe: rapid permeability.
Elsmere (Mapped only with soils of Dunday series.)	Fair: blows easily.	Fair	Moderate: water table at depth of 3 to 6 feet.	Severe: rapid permeability.
Epping: EhF	Poor: thin	Poor	Severe: siltstone at depth of 6 to 20 inches; 9 to 40 percent slopes.	Severe: 9 to 40 percent slopes.
Gannett: Ga	Poor: water table.	Poor	Severe: water table at depth of 0 to 20 inches.	Severe: water table at depth of 0 to 20 inches.
Goshen: GoA, GoB	Good	Fair to poor	Moderate: some flooding	Moderate: variable permeability in substratum.
Haverson: HaA	Fair if fertilized	Fair to good	Moderate: some flooding	Moderate: unstable fill material; moderate to moderately rapid permeability.
Holt: HtB, HtC (For interpretations of Tuthill soils, refer to Tuthill series.)	Fair: blows easily.	Fair to good	Slight to moderate: 0 to 9 percent slopes; bedded soft sandstone in places.	Moderate to severe: moderately rapid to rapid permeability; 0 to 9 percent slopes.
Hoven: Hv	Not suitable	Very poor	Severe: slow permeability; ponded water.	Slight to severe: variable substratum; some foreign water.

interpretations of soil properties

land (Bo), Gravelly land (Gr), Marsh (Ma), and Rock outcrop (in Cr)]

Soil features affecting—				
Highways	Farm ponds		Terraces and diversions	Foundations for low buildings
	Reservoir areas	Embankments		
Moderately susceptible to frost heaving.	Too porous to hold water in most places.	Fair stability.	Sand and gravel at depth of 20 to 40 inches.	Most features favorable; fair shear strength.
Subject to soil blowing.	Too porous to hold water.	Sandy material; rapid seepage.	Sandy substratum; erodible material.	Most features favorable; fair shear strength.
Subject to soil blowing.	Too porous to hold water.	Sandy material; rapid seepage.	Sandy, erodible material; difficult to establish vegetation.	Most features favorable.
3 to 40 percent slopes; erodible material.	Pervious substratum requires compacted seal blanket.	Poor stability; poor compaction; subject to piping.	Soft sandstone at depth of less than 24 inches; erodible material; difficult to establish vegetation.	Fair to poor bearing capacity.
9 to 12 percent slopes; erodible material.	Substratum may require compacted seal blanket.	Poor stability; poor compaction; subject to piping.	Erodible material.	Poor bearing capacity.
Subject to frost heave; unstable material.	Pervious substratum may require seal blanket.	Fair to poor stability; medium to high compressibility.	Moderately slow permeability in subsoil.	Poor bearing capacity.
Subject to soil blowing.	Too porous to hold water.	Sandy material; rapid seepage.	Rapid permeability; subject to soil blowing.	Most features favorable.
Water table at depth of 3 to 6 feet.	Water table at depth of 3 to 6 feet; suitable for dug ponds.	Sandy material; rapid seepage	Not applicable; erodible material; water table at depth of 3 to 6 feet.	Water table at depth of 3 to 6 feet.
9 to 40 percent slopes; erodible material.	Most features favorable.	Limited material; poor stability.	Bedded siltstone at depth of 6 to 20 inches; difficult to establish vegetation.	Poor bearing capacity.
Water table at depth of 0 to 20 inches.	Water table at depth of 0 to 20 inches.	Fair stability.	Not applicable; wet and difficult to drain.	Water table at depth of 0 to 20 inches.
Subject to frost heave; some flooding.	May require seal blanket in places.	Fair to poor stability.	Most features favorable.	Poor to fair bearing capacity.
Occasional flooding.	Pervious substratum requires seal blanket.	Poor stability; moderate permeability.	Erodible material.	Fair to good bearing capacity.
Erodible material.	Too porous to hold water.	Fair stability; some seepage due to sandy material.	Sandstone substratum in places; erodible material.	Most features favorable; fair to good shear strength.
Subject to frost heave and ponded water.	Most features favorable; seal blanket required in places.	Fair to poor stability; poor shear strength.	Not applicable.	Not favorable; subject to ponded water.

371-550—71——5

TABLE 5.—*Engineering*

Soil series and map symbols	Suitability as a source of—		Soil limitations for sewage disposal	
	Topsoil	Road fill	Septic tank filter fields	Lagoon
Kadoka: KaB	Good	Poor	Moderate: bedded siltstone and silt at depth of 20 to 40 inches.	Moderate: 3 to 5 percent slopes.
Keith: KeA, KeB, KhD, KrA, KrB, KuC. (For interpretations of Colby soil in KhD, of Rosebud soils in KrA and KrB, and of Ulysses soil in KuC, refer to the Colby, Rosebud, and Ulysses series, respectively.)	Good	Fair to poor	Moderate: moderately slow permeability in subsoil; in some places sandstone or gravel at depth below 40 inches.	Moderate: 0 to 12 percent slopes.
Lamo: La	Good	Poor	Severe: water table at depth of 2 to 5 feet.	Severe: water table at depth of 2 to 5 feet.
Loup: Lo	Fair: blows easily.	Poor	Severe: water table at surface to depth of about 40 inches.	Severe: water table at surface to depth of about 40 inches.
Minatare: Me	Not suitable	Very poor	Severe: very slow permeability; water table at depth of 2 to 5 feet.	Severe: water table at depth of 2 to 5 feet; unstable material.
Mosher: Mm (For interpretations of Minatare soil in Me, refer to the Minatare series.)	Good	Poor	Severe: very slow permeability; water table at depth of 3 to 7 feet.	Moderate: unstable material; water table at depth of 3 to 7 feet.
Oglala: OcE, OrA, OrB (For interpretations of Canyon soil in OcE and of Rosebud soils in OrA and OrB, refer to the Canyon and Rosebud series, respectively.)	Good	Fair	Moderate to severe: 3 to 40 percent slopes; weekly cemented sandstone at depth of 40 to 60 inches or more.	Moderate: 3 to 40 percent slopes; moderate permeability.
Richfield: RkA, RkB	Good	Poor	Moderate: moderately slow permeability.	Slight to moderate: permeable substratum.
Rosebud (Mapped only with soils of the Canyon, Keith, and Oglala series.)	Good	Fair	Moderate: 3 to 12 percent slopes; weakly cemented sandstone or caliche at depth of 20 to 40 inches.	Moderate to severe: 3 to 12 percent slopes; permeable substratum.
Tassel: TaF (For interpretations of Anselmo soil, refer to Anselmo series.)	Poor: thin	Fair to good	Moderate to severe: 18 to 40 percent slopes; weakly cemented sandstone at depth of 6 to 25 inches.	Severe: 18 to 40 percent slopes.
Tuthill: TnB, TnC (For interpretations of Anselmo soils, refer to Anselmo series.)	Fair: blows easily.	Good	Slight	Moderate to severe: moderate permeability; too porous in places.
Ulysses	Good	Fair to poor	Moderate: 5 to 9 percent slopes.	Moderate: 5 to 9 percent slopes.
Valentine: VaC, VaD, VeD (For interpretations of Tassel soil in VeD, refer to Tassel series.)	Not suitable	Good	Slight to moderate: 0 to 35 percent slopes.	Severe: rapid permeability.
Vetal: VgA, VhD (For interpretations of Goshen soil in VgA and of Holt soil in VhD, refer to the Goshen and Holt series, respectively.)	Fair: blows easily.	Good	Slight	Severe: moderately rapid permeability.

interpretations of soil properties—Continued

Soil features affecting—				
Highways	Farm ponds		Terraces and diversions	Foundations for low buildings
	Reservoir areas	Embankments		
Subject to frost heave; erodible material.	Most features favorable; seal blanket required in places.	Fair to poor stability; subject to piping.	Bedded siltstone and silt at depth of 20 to 40 inches.	Poor bearing capacity.
Subject to frost heave; erodible material.	Substratum may require seal blanket.	Fair to poor stability; subject to piping.	Most features favorable	Poor bearing capacity.
Water table at depth of 2 to 5 feet.	Water table at depth of 2 to 5 feet; suitable for dug ponds.	Poor to fair stability	Not applicable; water table at depth of 2 to 5 feet.	Water table at depth of 2 to 5 feet.
Water table at surface to depth of about 40 inches.	Water table at surface to depth of about 40 inches; suitable for dug ponds.	Sandy material; rapid seepage.	Not applicable; water table at surface to depth of about 40 inches.	Water table at surface to depth of about 40 inches.
Subject to frost heave; water table at depth of 2 to 5 feet.	Water table at depth of 2 to 5 feet; saline water.	Poor stability	Not applicable water table at depth of 2 to 5 feet.	Water table at depth of 2 to 5 feet.
Subject to frost heave; water table at depth of 3 to 7 feet.	Water table at depth of 3 to 7 feet.	Poor stability	Not applicable; water table at depth of 3 to 7 feet.	Poor to fair bearing capacity; water table at depth of 3 to 7 feet.
3 to 40 percent slopes; erodible material.	Pervious substratum requires seal blanket.	Poor stability; subject to piping.	Most features favorable on slopes up to 12 percent.	Poor to fair bearing capacity.
Subject to frost heave	Substratum may require seal blanket.	Fair to poor stability	Most features favorable	Poor bearing capacity.
Moderately susceptible to frost heave; erodible material.	Pervious substratum requires seal blanket.	Poor stability; poor compaction; subject to piping.	Sandstone or caliche at depth of 20 to 40 inches.	Fair bearing capacity.
18 to 40 percent slopes; erodible material.	Too porous to hold water	Fair stability; subject to seepage.	Shallow to sandstone; difficult to establish vegetation.	Most features favorable.
Subject to soil blowing	Too porous to hold water in places.	Fair stability; subject to seepage.	Most features favorable	Most features favorable.
Subject to frost heave; erodible material.	Pervious substratum requires seal blanket.	Poor stability; subject to piping.	Most features favorable	Poor bearing capacity
Loose sand hinders hauling; erodible material.	Too porous to hold water	Sandy material; rapid seepage.	Sandy, erodible material	Most features favorable.
Subject to soil blowing	Too porous to hold water in most places.	Sandy material; rapid seepage.	Sandy, erodible material	Most features favorable.

TABLE 6.—*Engineering test data*

[Tests performed by the South Dakota Department of Highways in cooperation with the U.S. Bureau of Public Roads, in accordance with standard procedures of the American Association of State Highway Officials (AASHO) (*1*)]

Soil name and location	Parent material	Depth	Mechanical analysis [1]— Percentage passing sieve— No. 40 (0.42 mm.)	Mechanical analysis [1]— Percentage passing sieve— No. 200 (0.074 mm.)	Liquid limit	Plasticity index	Classification AASHO [2]	Classification Unified [3]
		Inches						
Dawes silt loam. (250 feet west and 130 feet north of the second telephone pole north of the southeast corner, section 5, T. 36 N., R. 37 W.)	Loess.	0–8	100	87	33	11	A-6(8)	ML-CL
		8–12½	100	85	33	14	A-6(10)	CL
		12½–21	100	88	43	23	A-7-6(14)	CL
		21–27	100	89	40	20	A-6(12)	CL
		27–31	100	88	37	14	A-6(10)	ML-CL
		31–38	100	89	35	13	A-6(9)	ML-CL
		38–44	100	86	32	11	A-6(8)	CL
		44–60	100	88	32	9	A-4(8)	ML-CL
Goshen silt loam. (0.2 mile west and 295 feet north of the southeast corner, section 6, T. 37 N., R. 38 W.)	Local alluvium.	0–7	100	96	47	16	A-7-5(12)	ML
		7–12	100	96	43	19	A-7-6(12)	CL
		12–17	100	97	46	23	A-7-6(14)	CL
		17–21	100	97	42	16	A-7-6(11)	ML-CL
		21–29	100	97	51	27	A-7-6(17)	CH
		29–39	100	97	44	21	A-7-6(13)	CL
		39–43	100	97	45	19	A-7-6(13)	ML-CL
		43–48	100	94	44	21	A-7-6(13)	CL
		48–54	100	90	38	12	A-6(9)	ML-CL
		54–60	100	87	31	4	A-4(8)	ML
Richfield silt loam. (855 feet north and 600 feet east of the southwest corner, section 32, T. 37 N., R. 36 W.)	Loess.	0–6	100	91	35	13	A-6(9)	ML-CL
		6–10	100	92	39	17	A-6(11)	CL
		10–16	100	91	42	22	A-7-6(13)	CL
		16–24	100	92	40	17	A-6(11)	CL
		24–33	100	92	35	12	A-6(9)	ML-CL
		33–44	100	90	33	8	A-4(8)	ML-CL
		44–54	100	99	32	9	A-4(8)	ML-CL

[1] Mechanical analysis according to the AASHO Designation: T 88–57 (*1*). Results by this procedure may differ somewhat from results obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method, and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method, and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analysis data used in this table are not suitable for naming textural classes for soils.

[2] Based on The Classification of Soils and Soil-Aggregate Mixture for Highway Construction Purposes, AASHO Designation: M 145–49 (*1*).

[3] SCS and BPR have agreed to consider that all soils having plasticity indexes within two points of the A-line are to be given a borderline classification. An example of a borderline classification obtained by this use is ML–CL.

Suitability of the soils for topsoil depends largely on thickness, texture, content of organic matter, and natural fertility of a soil. Topsoil is used as a topdressing for lawns, gardens, roadbanks, and the like. The ratings indicate suitability for such use. An eroded soil, for example, generally does not have enough topsoil, and a clayey soil tends to be difficult to work.

Road fill can be of most any kind of soil material, but clays that have high shrink-swell potential require special compaction and close moisture control both during and after construction. Sands have good bearing capacity but are difficult to confine in a fill.

No estimates are shown in table 5 for suitability of soils as sources of sand and gravel, or for drainage structures, or waterways. Few soils in Bennett County are good sources of sand and gravel.

Drainage is only a minor concern in the county. For example, small areas of Hoven soils within cultivated fields can be drained by open ditches where suitable outlets are present. Also, water ponding on Hoven soils can be lessened by terracing adjacent slopes.

Gannett, Elsmere, Lamo, Loup, Minatare, and Mosher soils have a water table within 7 feet of the surface. Most areas of these soils are used as hay meadows and for grazing, as the water table contributes to good growth of forage and is a favorable feature. Some areas of Gannett soils, however, have been partly drained to ease haying operations.

Most waterway construction in the county is on the soils in the Keith-Rosebud soil association. Care must be taken in reshaping waterways on these soils because they are susceptible to water erosion until vegetation is well established.

Engineering test data

Table 6 lists data obtained by laboratory tests on samples from three soil profiles. The tests were performed by the South Dakota Department of Highways in coopera-

TABLE 7.—*Engineering test data from soil samples taken along proposed highway routes*

[Tests made by South Dakota Department of Highways]

Soil series	Horizon	Number of samples tested	Mechanical analyses — Percentage passing sieve— No. 10 (2.0 mm.)		No. 40 (0.42 mm.)		No. 200 (0.074 mm.)		Liquid limit		Plasticity i
			Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Anselmo.	A	3	100	100	97–99	98	27–37	33	20–23	21	2–3
	B	6	100	100	97–99	98	25–34	29	19–21	20	1-3
	C	6	99–100	100	96–99	98	23–44	33	0–27	20	0–12
Canyon.	A	3	100	100	99–100	100	68–86	76	28–34	30	3–10
	C	4	64–100	82	60–94	76	35–50	43	0–27	19	0–5
Dawes.	A	2	100	100	100	100	83–90	87	36–44	40	13–18
	B	4	99–100	100	99–100	100	75–85	80	30–35	32	8–14
	C	1	100	100	100	100	59	59	26	26	10
Dunday.	A	3	100	100	97–99	98	20–25	22	0–20	13	0–2
	C	3	100	100	95–96	95	14–16	15	15–16	15	1–2
Goshen.	A	9	100	100	100	100	81–95	89	34–41	38	5–18
	B	11	100	100	97–100	100	84–96	92	34–47	41	12–22
	C	1	100	100	100	100	68	68	34	34	5
Holt.	C	2	100	100	99	99	9–18	14	15–16	16	1–3
Keith.	A	12	100	100	97–100	100	73–89	83	32–40	36	4–14
	B	13	94–100	100	88–100	99	76–97	85	28–47	37	5–10
	C	14	100	100	98 100	100	78–92	84	28–39	33	2–15
Minatare.	A	1	100	100	99	99	58	58	26	26	3
	B	2	100	100	99–100	100	68–90	79	49–56	53	30–31
	C	1	100	100	97	97	83	83	40	40	14
Mosher.	A	1	100	100	99	99	69	69	33	33	6
	B	3	100	100	99–100	99	63–73	68	27–37	32	9-16
	C	1	100	100	99	99	73	73	29	29	5
Oglala.	A	3	99–100	100	98–100	99	71-88	81	33–38	35	5–12
	B	1	100	100	95	95	68	68	40	40	8
	C	8	98–100	100	95–100	98	64–91	75	27–41	34	5-11
Rosebud.	A	10	100	100	86–100	98	69–91	78	28–39	33	4–12
	B	17	99–100	100	92–100	98	58–86	70	27–39	31	3–13
	C	20	88–100	98	83–100	95	56–81	67	26–36	30	1–12
Ulysses.	B	2	100	100	99–100	100	73–85	79	30–31	31	3–7
	C	2	100	100	99–100	100	77–91	84	37–38	38	9–14
Valentine.	C	20	100	100	93–99	97	2–9	5	0–16	4	0 2

tion with the U.S. Bureau of Public Roads (BPR). These tests were conducted in accordance with standard procedures of the American Association of State Highway Officials (*1*). Some of the terms used in table 6 are explained in the following paragraphs.

In mechanical analysis, the soil components are sorted by particle size. Sand and other granular material are retained on a No. 200 sieve, but finer particles pass through the openings. Clay (not shown in table) is the fraction smaller than 0.002 millimeter in diameter. The material intermediate in size between that held on the No. 200 sieve and that having a diameter of 0.002 millimeter is mostly silt.

The tests for liquid limit measure the effect of water on the consistence of the soil material. As the moisture content of a clayey soil is increased from a dry state, the material changes from a semisolid to a plastic state. If the moisture content is further increased, the material changes from a plastic to a liquid state. The plastic limit is the moisture content at which the soil material passes from a semisolid to a plastic state. The liquid limit is the moisture content at which the material passes from a plastic to a liquid state. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is plastic.

Table 7 lists data obtained by laboratory tests on samples taken along the routes of proposed new highways. These tests were performed by the South Dakota Department of Highways. The samples were taken at depth breaks that reflected distinct changes in color and, therefore, may include material from more than one major horizon of a given series.

Several samples of each horizon of the selected soils were tested. Table 7 shows the actual range and the average value for each of several properties. The AASHO and Unified classifications listed in the last two columns of table 7 were based on the average values.

Formation and Classification of the Soils

This section consists of four parts. The first part relates the five factors of soil formation to the soils in Bennett County. The second part tells of some of the processes at work in forming soil horizons. In the third part, the systems for classifying soils are discussed, and the soils in Bennett County are placed in the currently used system. In the fourth part is a table showing chemical and mechanical analyses of selected soils.

Formation of the Soils

Soil is the product of the interaction of five major factors of soil formation. These factors are climate, plant and animal life, parent material, relief, and time. The characteristics of the soils in Bennett County, and elsewhere, are determined by the interaction of the soil-forming factors that are or have been present at that site.

Climate

The climate of Bennett County is semiarid and continental. Summers are hot and winters are cold. Seasonal variations in temperature and precipitation are wide. In this kind of climate, soil forming is moderately slow. Additional information on climate is in the section "General Nature of the County."

The climate is fairly uniform throughout the county and probably is similar to that under which the soils in the county formed. Climate alone, therefore, does not account for the formation of different kinds of soils in Bennett County. The effects of climate are modified by the effects of the other four factors of soil formation.

Plant and animal life

Plants, animals, insects, earthworms, bacteria, and fungi are important in the formation of soils. Among the changes they cause are gains in organic matter, gains or losses in plant nutrients, and changes in structure and porosity.

The well-drained, gently sloping soils on the uplands of Bennett County have a native cover mostly of mid and short grasses. The kinds of grasses vary with soil texture, but the density of grasses is about the same. As a result, most soils have horizons of organic-matter accumulation of about the same thickness. The Canyon, Colby, Tassel, and other of the steeper soils, however, lose rainfall through runoff and have a less dense cover of grass and a thinner horizon of organic-matter accumulation. The nearly level, concave soils receive runoff which favors dense stands of mid and tall grasses. The Goshen and Vetal soils are of this kind and have thick horizons of organic-matter accumulation. Where such soils have a water table, tall grasses are dominant, as on the Gannett, Lamo, and Loup soils.

The scattered stands of ponderosa pine in the Oglala-Canyon association are stunted in size, are sparse, and have a grass understory. These trees appear to have had little or no effect on the development of different kinds of soil in the county.

Some forms of animal life are selective of the kinds of soil or soil materials they inhabit. Evidence of earthworm activity is common in the Goshen, Keith, Ulysses and similar friable, finer textured soils, but the Valentine and other coarse-textured soils show little evidence of this activity.

Disturbance by man has influenced changes in the soils. In some fields the A and B horizons have been mixed through tillage. Where man has not properly managed the soils, the A horizon may have been thinned by erosion. In small cultivated tracts of Canyon and Colby soils, the thin A horizon has been washed or blown away, or it has been mixed with underlying, light-colored materials and has lost its identity.

Parent material

Parent material is the unconsolidated mass from which a soil formed. It determines the limits of the chemical and physical characteristics of the soil. The parent material in Bennett County can be divided into two broad classes. One class is weathered Tertiary sediments from which the soils developed in place, and the other is sediments transported and redeposited by wind or water.

The Tertiary sediments occupy about three-fourths of the county. They are of continental origin and remain as an upland depositional plain. The Tertiary sediments in

Bennett County can be divided into three groups of geologic formations: the Arickaree, Ogallala, and Rosebud.

The Arickaree group, which occupies much of the surface area of the county, consists of the Sharps, Monroe Creek, and Harrison formations. The Sharps formation is light pinkish-gray, soft feldspathic sandstone that is very fine grained and generally calcareous (*3*, *4*, *7*). The lower part of the sandstone is somewhat clayey, has potatolike, calcareous concretions 2 to 5 inches in diameter, and generally has a zone of volcanic ash at its base. The Sharps formation is exposed at the lower elevations along the north county line, mainly along Bear in the Lodge Creek and other drainageways. In Bennett County the small areas of Kadoka and Epping soils formed in materials weathered from the lower part of the Sharps formation.

The Monroe Creek formation consists of pink to brown quartzose sandstone that is noncalcareous and consists of very fine and well-sorted grains. It contains less clay than the Sharps formation and is uniform in composition. It is poorly consolidated, is in massive beds, and weathers to a light grayish-buff color. The lower part contains calcareous nodular concretions.

The Harrison formation consists of gray, massive, very fine sands that have distinct lime-centered layers. In the vicinity of Martin, surface areas of the Harrison formation contain many sandy to gravelly channel deposits that probably were laid down at a later period during the Tertiary age.

The Rosebud formation belongs to an unnamed group. It consists of interbedded pinkish sand, silt, and clay. Concretions and beds of reddish-buff silty clay, cemented by silica, occur throughout the formation (*7*). The extent of surface exposures of the Rosebud formation is small in the county.

The Ogallala group is represented by the Valentine and Ash Hollow formations in Bennett County. The Valentine formation consists of light-gray and light olive-greenish, very poorly consolidated, feldspathic or arkosic sand that has fine to medium grains. It is mostly noncalcareous but in places contains thin lenses cemented by lime. The Ash Hollow formation occurs mainly as a prominent, highly dissected cap rock at the higher elevations in the eastern part of the county. It consists of a light-gray, calcareous, arkosic sandstone that is strongly cemented.

The Canyon, Oglala, and Rosebud are the main soils formed in materials weathered from the Arickaree group. Holt, Tassel, and Tuthill soils formed in materials weathered from the Ogallala group. Where the materials from the Ogallala group have been transported by water or modified by wind, the Anselmo, Valentine, and Vetal soils occur.

The materials transported by water or wind in Bennett County are loess, eolian sand, and alluvium. The loess consists of silty deposits of uniform texture that are scattered throughout the county north of the sandhills. In most places these silty materials are less than 6 feet thick over the underlying Tertiary deposits, but in places they are as much as 15 feet thick. Generally, the loess occurs on slopes that face east and south. The Colby, Dawes, Keith, Richfield, and Ulysses soils formed in these silty materials.

Eolian sand makes up the Sand Hills formation, which extends across the southern part of the county. This formation consists of unconsolidated fine sand that was derived from the underlying Valentine formation. In the Pleistocene period this sand was reworked by wind action into a succession of dunes (*3*). The Dunday and Valentine soils formed in these materials.

Alluvium, or materials transported by water, were deposited many years ago or recently. Some of it has been transported from a long distance, and some from adjacent slopes. Goshen soils formed in local alluvium of Recent age. Alluvial deposits of Recent age consisting of sands, silts, and some fine gravel are on bottom lands and low terraces. The Bankard, Haverson, Lamo, and Loup soils formed in these materials.

Alluvium of older age occurs on moderately high terraces in the northeastern and eastern parts of the county. Near the village of Tuthill, there is an extensive terrace in which the material is Pleistocene or older. It consists of cross-bedded sands and gravel overlain by 2 to 4 feet of loamy to silty materials. The Altvan, Anselmo, Dawes, and Keith soils occupy these terraces. The Mosher and Minatare soils are on the lower, more poorly drained areas of the terraces.

Relief

Relief influences soil formation through its effect on drainage and runoff. These, in turn, affect plant cover, biologic activity, soil temperature, erosion, and the deposition of sediments. Colby, Goshen, Hoven, Keith, and Ulysses soils formed in similar materials but have differences that are associated with relief. Colby soils are on hilltops and steep slopes where runoff is great, and on these soils natural erosion has almost kept pace with soil formation. Ulysses soils are on the upper parts of convex slopes where enough water enters the soil to aid accumulation of organic matter and to leach carbonates from the surface layer. The gently sloping Keith soils have somewhat less runoff than the Ulysses soils, and carbonates are leached deeper in the profile. Also, more clay minerals have moved downward from the surface layer into the subsoil. Goshen soils occupy concave areas that receive runoff water and sediments from adjacent slopes. Goshen soils have thicker layers of organic-matter accumulation than Keith soils and have carbonates leached to greater depths. Hoven soils occur in depressions where runoff water ponds.

Time

The length of time that soil materials have been exposed to the other four factors of soil formation is reflected in the kinds of soil that form. Some landscapes have been stable for a long time. Soils on these sites have well-developed genetic horizons. The nearly level Richfield and Dawes soils are southeast of Martin on tablelands that probably are some of the oldest landscapes in the county. The Tuthill soils possibly also are relics of old landscapes. The youngest soils in Bennett County include the Bankard and Haverson soils that formed in recent alluvium and the Valentine soils that formed in sands only recently stabilized by vegetation.

Formation of Horizons

The processes that take place in the formation of soil horizons include (1) the accumulation of organic matter, (2) the leaching of calcium carbonates and bases, (3) the

reduction and transfer of iron, and (4) the formation and translocation of silicate clay minerals. One or more of these processes has been active in the formation of horizons in the soils of Bennett County.

Canyon, Colby, Tassel, and Valentine soils have accumulated very small amounts of organic matter. Keith, Richfield, Rosebud, and Tuthill are among the soils that have a moderate amount of organic matter. Goshen soils are moderately high in organic-matter content.

Well-drained soils that formed on uplands, such as the Keith, Richfield, and Rosebud, are leached of carbonates to a depth ranging from 15 to 30 inches. The moderately well drained Goshen soils are leached to a greater depth. Carbonates have not been leached from excessively drained, hilly, silty and loamy soils on uplands.

The reduction and transfer of iron, or gleying, occurs only in very poorly drained and poorly drained soils, such as the Gannett, Lamo, and Loup. The gray color of the subsurface horizons indicates reduction and loss of iron. The Lamo and Loup soils commonly have layers containing reddish-brown and yellowish-brown mottles, which indicate segregation of iron.

Many of the soils on uplands in this county have a B horizon in which there is a distinct and easily observed accumulation of clay minerals. It is assumed that this material was moved by water. Soil scientists generally agree that the leaching of bases usually precedes the formation of a horizon of clay accumulation. Exactly how the clay moves is not clear, but the parent material in which the soils of Bennett County formed have some of the properties associated with movement of clay. Among these properties are (1) sufficient clay in the parent material; (2) the presence of bases as flocculating agents; (3) the presence of dispersion agents, such as sodium; (4) the alternate wetting and drying of the soils; and (5) landscapes that are old enough for the factor of time to be significant. Keith, Richfield, Rosebud, and Tuthill soils are among the soils that have a horizon of clay accumulation.

If substantial amounts of sodium, which is a dispersion agent, have accumulated in the horizon of clay increase, the clay is in poor physical condition. If leaching continues and the soil deepens, the sodium is replaced by hydrogen and soils such as those of the Dawes series form.

Classification of the Soils

Soils are classified so that we can more easily remember their significant characteristics, assemble knowledge about them, see their relationship to each other and to the whole environment, and develop principles that will help us to understand their behavior and response to manipulations. First through classification and then through use of soil maps, we can apply our knowledge of soils to specific fields or other tracts of land.

Two systems of classifying soils have been used in the United States in recent years. The older system was adopted in 1938 (*2*) and was later revised (*18*). The system currently used was adopted by the National Cooperative Soil Survey in 1965. This system is under continual study. Readers interested in the development of the system should refer to the latest literature available (*15, 20*).

The current system of classification defines the classes in terms of observable and measurable properties of soils. It permits grouping of soils that are similar in morphology and genesis and is designed to accommodate all soils. It has six categories. Beginning with the most inclusive, the categories are the order, the suborder, the great group, the subgroup, the family, and the series. The placement of some soil series in the current system, particularly in families, may change as more precise information becomes available. In table 8 the soils of Bennett County are classified according to the current system. Following are brief descriptions of the six categories.

Order

Ten soil orders are recognized: Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate the soil orders are those that tend to give broad climatic groupings of soils. Two exceptions are the Entisols and the Histosols, which occur in many different climates.

Three soil orders are represented in Bennett County: Entisols, Aridisols, and Mollisols. Entisols lack genetic horizons or have only the beginnings of such horizons. Soils of this order in Bennett County were classified as Alluvial soils, Regosols, and Lithosols under the 1938 system.

Aridisols are soils of dry places. They have not had enough accumulation of organic matter to be dark colored in the uppermost 7 inches or more. Soils of this order in Bennett County were classified as Solonetz soils under the 1938 system.

Mollisols are friable soils that are high in bases and have a sufficient accumulation of organic matter to be dark colored in the uppermost 7 inches or more. Soils of this order in Bennett County were classified as Planosols and as Chestnut, Solonetz, and Humic Gley soils under the 1938 system.

Suborder

Each order is divided into suborders, primarily on the basis of soil characteristics that seem to produce classes with the greatest genetic similarity. The suborders narrow the broad climatic range allowed in the orders. The soil properties used to separate the suborders are those that reflect the presence or absence of waterlogging, or those that reflect soil differences resulting from climate or vegetation. (The suborders are not shown separately in table 8, because they are identified by the last part of the second word in the name of the subgroup.)

Great Group

Each suborder is divided into great groups on the basis of similarity in the kinds and sequence of major horizons and features. The horizons used to make separations are those in which clay, iron, and humus have accumulated, or those that have pans that interfere with the growth of roots or the movement of water. The features used are the self-mulching properties of clay, soil temperature, major differences in chemical composition, and the like. (The great groups are not shown separately in table 8, because they are indicated by the last word in the name of the subgroup.)

TABLE 8.—*Current classification of soil series in Bennett County* [1]

Series	Family	Subgroup	Order
Altvan	Fine-loamy, over sandy or sandy skeletal, mixed, mesic.	Aridic Argiustolls	Mollisols.
Anselmo	Coarse-loamy, mixed, mesic	Typic Haplustolls	Mollisols.
Bankard	Sandy, mixed, mesic	Ustic Torrifluvents	Entisols.
Canyon	Loamy, mixed, calcareous, mesic, shallow	Ustic Torriorthents	Entisols.
Colby	Coarse-silty, mixed, calcareous, mesic	Ustic Torriorthents	Entisols.
Dawes	Fine, mixed, mesic	Abruptic Paleustolls	Mollisols.
Dunday	Sandy, mixed, mesic	Torriorthentic Haplustolls	Mollisols.
Elsmere	Sand, mixed, mesic	Aquic Haplustolls	Mollisols.
Epping	Loamy, mixed, calcareous, mesic, shallow	Ustic Torriorthents	Entisols.
Gannett	Coarse-loamy, mixed, noncalcareous, mesic.	Typic Haplaquolls	Mollisols.
Goshen	Fine-silty, mixed, mesic	Pachic Argiustolls	Mollisols.
Haverson	Fine-loamy, mixed, calcareous, mesic	Ustic Torrifluvents	Entisols.
Holt	Coarse-loamy, mixed, mesic	Typic Argiustolls	Mollisols.
Hoven	Fine, montmorillonitic, mesic	Typic Natraquolls	Mollisols.
Kadoka	Fine-silty, mixed, mesic	Aridic Argiustolls	Mollisols.
Keith	Fine-silty, mixed, mesic	Aridic Argiustolls	Mollisols.
Lamo	Fine-silty, mixed, calcareous, mesic	Cumulic Haplaquolls	Mollisols.
Loup	Sandy, mixed, mesic	Typic Haplaquolls	Mollisols.
Minatare	Fine, mixed, mesic	Aquic Natrargids	Aridisols.
Mosher	Fine, mixed, mesic	Typic Natrustolls	Mollisols.
Oglala	Coarse-silty, mixed, mesic	Aridic Haplustolls	Mollisols.
Richfield	Fine, montmorillonitic, mesic	Aridic Argiustolls	Mollisols.
Rosebud	Fine-loamy, mixed, mesic	Aridic Argiustolls	Mollisols.
Tassel	Loamy, mixed, calcareous, mesic, shallow	Ustic Torriorthents	Entisols.
Tuthill	Fine-loamy, over sandy or sandy skeletal, mixed, mesic.	Aridic Argiustolls	Mollisols.
Ulysses	Fine-silty, mixed, mesic	Aridic Haplustolls	Mollisols.
Valentine	Mixed, mesic	Typic Ustipsamments	Entisols.
Vetal	Coarse-loamy, mixed, mesic	Pachic Haplustolls	Mollisols.

[1] The classifications given in this table were current at the time this survey was written.

SUBGROUP

Each great group is divided into subgroups. The soils in one of the subgroups represent the central, or typic, segment of the group; those in the others, called intergrades, have mainly the properties of one group but also one or more properties of another great group, suborder, or order. Some subgroups are made up of soils having properties that intergrade outside the range of any recognized great group, suborder, or order.

FAMILY

Families are established within a subgroup primarily on the basis of properties important in the growth of plants or in the behavior of soils when they are used for engineering. These properties include texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence.

Physical and Chemical Analyses

The data obtained by physical and chemical analyses of soils representative of the Dawes, Goshen, and Richfield series are given in table 9. Profiles of these selected soils [8] are described in the "Descriptions of the Soils." The data in table 9 are useful to soil scientists in classifying soils and in developing concepts of soil genesis. These data also are useful in estimating water-holding capacity, wind erosion, fertility, tilth, and other practical aspects that determine suitable management. The data on reaction, electrical conductivity, and percentage of exchangeable sodium are useful in evaluating the possibility of reclaiming and successfully managing saline-alkali areas.

Data on Epping, Kadoka, Keith, and Rosebud soils appear in the published soil survey for adjacent Shannon County.

Field and laboratory methods

All samples tested to obtain the data in table 9 were collected from carefully selected pits. If necessary, the sample was sieved after it was dried, and rock fragments larger than 3/4 inch in diameter were discarded. Then, the material remaining was rolled, crushed, and sieved by hand to remove rock fragments larger than 2 millimeters in diameter. Thus, unless otherwise noted, all laboratory analyses in table 9 are on material that passed the 2 millimeter sieve. The data are reported on an oven-dry basis. In table 9, data for exchangeable sodium are for amounts of sodium extracted by the ammonium acetate method minus the amounts soluble in the saturation extract.

Standard methods of the Soil Survey Laboratory were used to obtain most of the data in table 9. Determinations of the percentage of clay were made by the pipette method (*8,9,11*). The reaction of a saturated paste formed from soil and distilled water in a 1 to 1 ratio was measured with a glass electrode. Organic carbon was determined by wet combustion, using a modification of the Walkley-Black

[8] Profiles described by G. J. BUNTLEY, Associate Professor of Agronomy, South Dakota Agricultural Experiment Station.

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TABLE 9.—*Data from laboratory*

[Analyses made at Soil Survey Laboratory, Soil Conservation Service, Lincoln,

Soil	Horizon	Depth	Particle-size distribution					
			Coarse sand (2 to 0.5 mm.)	Medium sand (0.5 to 0.25 mm.)	Fine sand (0.25 to 0.1 mm.)	Very fine sand (0.1 to 0.05 mm.)	Silt (0.05 to 0.002 mm.)	Clay (less than 0.002 mm.)
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Dawes silt loam:	Ap	0–6	0.3	0.7	6.3	18.7	52.2	21.8
Location: 35 feet S. and 300 feet E. of	A12	6–9	.1	.5	6.2	19.1	53.0	21.1
fifth telephone pole S. of NW. corner	A2	9–11	.1	.4	6.0	19.3	53.6	20.6
of section 8, T. 36 N. R., 37 W.	B21t	11–17	.1	.3	4.3	12.5	38.6	44.2
Sample No. S58SD-4-3 (1-10).	B22t	17–22	.1	.2	5.3	15.2	43.8	35.4
Laboratory No. 8904–8913.	B31ca	22–27	.1	.2	6.3	17.2	50.7	25.5
	B32ca	27–32	.1	.1	7.4	18.8	52.3	21.3
	C1ca	32–39	.1	.1	5.5	19.7	55.3	19.4
	C2ca	39–47	.1	.1	5.1	22.2	55.6	17.1
	C3ca	47–60	.1	.1	4.8	23.3	55.8	16.0
Goshen silty clay loam:	Ap	0–7	.1	.1	1.1	11.7	58.8	28.2
Location: 0.4 mile E. and 100 feet S.	A12	7–11	.1	.1	1.1	9.6	59.2	30.0
of NW. corner of section 6, T. 37 N.,	B1	11–17	.1	.1	1.1	11.1	57.1	30.6
R. 39 W.	B21t	17–24	.1	.1	1.0	13.7	52.3	33.0
Sample No. S58SD-4-1 (1-10).	B22t	24–31	.1	.1	1.3	16.4	46.8	35.5
Laboratory No. 8885–8893.	B23t	31–38	.1	.1	1.7	18.9	46.6	32.8
	B31	38–44	.1	.1	1.9	20.1	48.2	29.8
	B32	44–49	.1	.1	2.5	22.0	45.1	30.2
	B33ca	49–55	.2	.2	3.1	25.9	45.0	25.6
Richfield silt loam:	Ap	0–7	.6	.6	4.1	17.0	55.0	22.7
Location: 2,110 feet E. and 385 feet S.	A12	7–9	.1	.3	3.4	17.4	51.8	27.0
of NW. corner of section 12, T. 36 N.	B21t	9–12	.1	.3	3.1	15.9	49.1	31.5
R. 37 W.	B22t	12–18	.1	.2	3.1	16.2	44.9	35.5
Sample No. S58SD-4-5 (1-10).	B23t	18–24	.2	.2	2.9	17.7	51.1	27.9
Laboratory No. 8923–8931.	B31ca	24–30	.2	.1	1.8	17.7	61.4	18.8
	B32ca	30–36	.3	.2	1.9	19.1	58.9	19.6
	Cca	36–48	.3	.2	2.2	23.4	56.0	17.9
	C&R	48–68	.8	.5	3.2	31.2	50.3	14.0

method (*12*). The calcium carbonate equivalent was determined by measuring the volume of carbon-dioxide emitted from soil samples treated with concentrated hydrochloric acid. The cation exchange capacity was determined by direct distillation of absorbed ammonia (*12*). To determine the extractable calcium and magnesium, calcium was separated as calcium oxalate and magnesium as magnesium ammonium phosphate (*12*). Extractable sodium and potassium were determined on ammonium acetate extracts with a flame spectrophotometer. The methods of the U.S. Salinity Laboratory were used to obtain the saturation extract (*13*). Soluble sodium was determined on the saturation extract with a flame spectrophotometer.

General Nature of the County

Discussed in this section are the settlement and population of Bennett County, transportation and markets, cultural and recreational facilities, natural resources, climate, and farming and ranching.

Settlement and Population

Bennett County was a part of Lugenbeel County created by the Dakota Territory legislature in 1875 (*17*). The 1909 legislature eliminated Lugenbeel County and created Bennett County. By ruling of the 1911 legislature the county was rebounded on the east to conform to the boundaries between the Pine Ridge and the Rosebud Indian Reservations. Until it was organized in 1912, Bennett County was under the administration of Fall River County.

Prior to the organization in 1912, the area was a part of the Pine Ridge reservation set aside for the Ogalala tribe of the Sioux Indians, in accordance with the terms of the Laramie Treaty of 1868.

Ownership of reservation land was at first held in common by the tribe. The Treaty of 1889 provided for making allotments of land to heads of Indian families and to individuals in a manner similar to that provided in homestead laws elsewhere in the United States. Many of the Indian allotments in Bennett County were in the northern part of the county, but tracts were scattered throughout the rest of the county.

An act of Congress in 1910 provided for opening nonalloted lands in accordance with the provisions of the Homestead Act. As a result, the county was quickly settled in the years between 1910 and 1930. Most of this settlement was made in the Keith-Rosebud and the Anselmo soil associations.

analyses of representative soils

Nebraska. Dashes indicate value is not determined or that category does not apply]

pH (1:1)	Organic carbon	Electrical conductivity	Calcium carbonate equivalent	Cation-exchange capacity NH_4OAc	Extractable cations					Exchange-able sodium
					Ca	Mg	H	Na	K	
	Percent	*Mmho./cm at 25° C.*	*Percent*	*Meq./100 gm. of soil*	*Meq./100 gm. of soil*	*Meq./100 gm. of soil*	*Meq./100 gm. of soil*	*Meq./100 gm. of soil*	*Meq./100 gm. of soil*	*Percent*
6. 9	1. 50	0. 7	1	18. 8	12. 9	3. 0	3. 6	0. 1	2. 6	1
6. 9	0. 71	. 5	1	15. 0	9. 1	3. 4	3. 2	. 5	2. 2	3
7. 2	. 58	. 5	1	14. 0	7. 6	3. 4	2. 0	. 7	2. 2	4
7. 4	. 72	. 5	1	31. 5	15. 7	10. 6	2. 1	2. 5	4. 7	7
8. 1	. 55	. 7	1	27. 5	14. 2	10. 2	0. 8	2. 6	4. 4	8
8. 5	. 39	1. 4	2	23. 7	—	—	—	2. 9	4. 1	10
8. 0	. 28	5. 6	8	20. 1	—	—	—	3. 1	3. 7	8
7. 9	. 21	6. 4	10	18. 9	—	—	—	3. 5	3. 6	10
7. 9	. 17	7. 2	6	19. 1	—	—	—	3. 8	3. 7	10
7. 9	. 14	7. 2	6	18. 9	—	—	—	3. 7	3. 6	10
6. 2	3. 40	. 7	—	27. 0	19. 6	3. 0	6. 3	. 1	3. 6	—
6. 4	2. 41	. 4	—	26. 8	20. 0	3. 3	6. 0	. 1	2. 9	—
6. 5	1. 67	. 4	1	25. 6	18. 4	3. 5	5. 5	. 1	2. 4	—
6. 5	1. 06	. 4	1	25. 6	18. 5	4. 2	4. 9	. 1	2. 5	—
6. 5	. 74	. 4	1	27. 4	19. 9	4. 8	4. 1	. 1	2. 8	—
6. 7	. 68	. 4	1	26. 9	20. 0	4. 5	2. 9	. 1	3. 0	—
6. 9	. 71	. 4	1	26. 5	20. 0	4. 5	2. 5	. 1	3. 0	—
7. 1	. 84	. 4	1	26. 6	21. 5	4. 2	2. 5	. 1	3. 0	—
7. 8	. 60	. 5	2	25. 3	—	—	—	. 1	3. 0	—
6. 4	1. 53	. 4	—	19. 2	11. 8	3. 8	4. 0	. 1	2. 2	—
6. 6	0. 78	. 4	1	21. 0	14. 2	4. 8	3. 6	. 1	1. 0	—
6. 9	. 67	. 4	1	23. 1	15. 5	6. 0	2. 4	. 1	0. 4	—
7. 1	. 52	. 4	1	26. 5	17. 6	7. 5	2. 0	. 1	2. 8	—
7. 4	. 49	. 5	1	24. 8	17. 7	7. 8	1. 6	. 1	. 7	—
8. 3	. 39	. 6	10	21. 3	—	—	—	. 2	1. 0	—
8. 4	. 27	. 6	9	20. 4	—	—	—	. 4	. 6	—
8. 4	. 18	. 7	7	19. 7	—	—	—	. 9	. 8	—
8. 4	. 10	1. 1	5	18. 8	—	—	—	1. 4	. 4	—

By 1920, the county had a population of 1,924. The peak in population was quickly reached in 1930, when the county had 4,590 inhabitants. Since then population has steadily declined. The 1960 census lists 3,053 inhabitants, of which 2,432 were whites and 612 were Indians. The county had a net loss in population of about 10 percent between 1950 and 1960 (*14*).

All of the population is classed as rural. In 1960, Martin, the largest town in the county, had a population of 1,184. The 1960 census lists 44 percent of the population as rural-farm; 41.5 percent as under 18 years of age; and 73 percent of the males, 14 years and older, as the labor force.

Transportation and Markets

Martin is an inland town. Movement of grain, livestock, and freight is by truck lines and farm-owned trucks because no railroad passes through the county. Hard-surfaced State and Federal highways bisect the county in both north-south and east-west directions. Secondary hard-surfaced and graveled roads connect schools and rural stores and feed into the two main highways.

Wheat and other grains are marketed outside the county. Grain elevators are located in Nebraska at Cody, Merriman, and Gordon. Some of the grain is marketed at Winner, S. Dak., and other rail points 100 miles or more to the east. Much of the livestock is marketed through local sales barns. Livestock sales barns are at Martin and Winner in South Dakota and at Gordon, Merriman, and Valentine in Nebraska. Feeder calves are often sold direct to corn-belt feeders. Some are shipped by truck and rail to central markets at Sioux City, Iowa, and Omaha, Nebr. Small amounts of fed cattle go to packers at Denver, Colo., and Rapid City, S. Dak.

Cultural and Recreational Facilities

Most community life in the county centers around Martin, the county seat.

Ten common school districts operate elementary schools in all parts of the county. A graded elementary school in Martin serves the central part of the county. The Bureau of Indian Affairs operates a federal elementary school for Indian children at Allen in the northern part of the county. Also in Martin is an accredited county high school that has departments of vocational agriculture and home economics.

Seven churches of the Roman Catholic and the Protestant faiths are located in Martin. Several rural churches of various denominations are elsewhere in the county.

A civic auditorium operated by the American Legion is in the county seat and provides facilities for high school athletics and other school activities, and for conventions, dances, concerts, stage shows, crop shows, and various agricultural and trade exhibits.

A new country club, Markota Acres, has a golf course, tennis courts, and a swimming pool. Local rodeos and an amateur baseball league provide summer recreation. A movie theater and a bowling alley provide winter recreation. Hunting and fishing are popular with many residents.

In addition to the retail stores commonly associated with a rural trade center, Martin has a community hospital, medical clinic, bank, newspaper, and a livestock sales barn.

Natural Resources

No known mineral resources are in the county. Soil, grass, and water are the main resources. Ground water of fair to good quality is available at shallow depth in most parts of the county. Small tracts as much as 80 acres in size are irrigated from wells near the village of Tuthill. Farmers show interest in further development of this kind of irrigation.

Climate of Bennett County [9]

The following climatic summary of Bennett County is based on records taken at Martin, the county seat, during the 30-year period, 1934-64. Martin, at an elevation of 3,331, is located a short distance to the west and south of the county center. Partly because the gradient across the county is small, the climate at Martin is representative for the county.

Bennett County has a semiarid, continental climate that is characterized by cold winters and hot summers. The rolling prairie terrain of the county has no large bodies of water to affect the climate, and none are nearby.

The range in temperature is wide seasonally and daily in Bennett County. Summer temperatures occasionally climb to above 100° F. In winter, temperatures may drop to 30° below zero or lower. A reading of 100° or higher can be expected about 3 days in July, 2 days in August, and 1 day in June. Temperatures of 30° below zero or lower can be expected about once in 5 years in February. Temperatures of 20° below zero may occur on about 1 day each year in January and about 1 day in 2 years in February. On the average, temperatures fall to zero or lower 18 days per year and fail to climb above zero at least 1 day per year.

Table 10 shows the probabilities of specified temperatures after certain dates in spring and before certain dates in fall. Probability is 50 percent, or about 5 years in 10, that a temperature of 32°F. or lower will occur at Martin on May 13 or later. May 13, then, is the average date in spring for the freeze threshold. Similarly in the fall, the probability is 50 percent that a temperature of 32°F. will occur at Martin on or before September 26.

Other data on temperature and precipitation are given by month in table 11.

The average annual precipitation at Martin is 16.6 inches, of which 13.4 inches, or about 80 percent, falls during the growing season (April-September). The annual precipitation ranged from 9.82 inches in 1940 to 25.85 inches in 1942. The main source of rain during the growing season is thundershowers, in which rains widely vary in intensity. A rainfall of 1 inch or more in 1 hour can be expected about 1 year in 2. Two inches or more of rain in 1 hour can be expected about 1 year in 15. Expected about once in 3 years is a 24-hour rain of 2 inches or more, and expected about once in 10 years is a 24-hour rain of 3 inches or more.

A heavy snow cover may hinder ranch and farm activity during winter, but snow cover protects pastures and fall-seeded crops. The average seasonal snowfall at Martin

[9] By WALTER SPUHLER, State climatologist, Weather Bureau, U.S. Dept. of Commerce, South Dakota State University, Brookings, South Dakota.

TABLE 10.—*Probabilities of specified temperatures in spring and fall*

[Data obtained from records at Martin, 1934–63 [1]]

Probability	Dates for given probability and temperature					
	16° F. or lower	20° F. or lower	24° F. or lower	28° F. or lower	32° F. or lower	36° F. or lower
After a specified date in spring:						
90 percent	March 10	March 17	April 2	April 12	April 20	May 4.
70 percent	March 20	March 28	April 8	April 20	April 28	May 11.
50 percent	April 4	April 12	April 20	May 2	May 13	May 23.
30 percent	April 20	April 27	May 2	May 14	May 27	June 5.
10 percent	April 28	May 8	May 9	May 20	June 4	June 12.
Before a specified date in fall:						
10 percent	October 16	October 4	September 26	September 18	September 1	September 1.
30 percent	October 23	October 13	October 4	September 26	September 10	September 6.
50 percent	November 6	October 28	October 19	October 12	September 26	September 19.
70 percent	November 18	November 13	November 3	October 28	October 12	October 3.
90 percent	November 26	November 22	November 11	November 6	October 21	October 8.

[1] Prepared by WILLIAM F. LYTLE, South Dakota State University.

TABLE 11.—*Temperature and precipitation* [1]

[All data obtained from records at Martin for the period 1934–63. Elevation 3,331 feet]

Month	Temperature				Precipitation							
			Two years in 10 will have—					One year in 10 will have—			Average number of days with—	
	Average daily maximum	Average daily minimum	Average maximum temperature equal to or higher than—	Average minimum temperature equal to or lower than—	Average total	Maximum total	Minimum total	Less than—	More than—	Average total snowfall	Snowfall 1 inch or more	Depth of snow cover 1 inch or more
	°F.	°F.	°F.	°F.	Inches	Inches	Inches	Inches	Inches	Inches		
January	33.3	10.5	42.4	1.1	0.33	1.15	0	0.08	0.76	5	2	13
February	37.0	13.7	47.9	4.2	.49	2.29	0	.22	1.49	6	2	13
March	44.6	21.2	53.0	14.6	.72	1.51	.22	.24	1.29	7	3	10
April	58.8	32.5	66.1	27.8	1.57	6.61	.30	.40	4.17	4	2	2
May	69.8	43.7	76.6	39.6	3.01	6.98	.20	.83	5.73	1	(2)	(2)
June	79.0	52.6	85.7	49.9	3.50	6.57	.96	1.66	5.53	0	0	0
July	88.6	59.9	94.5	55.9	2.05	5.61	.23	.57	3.22	0	0	0
August	87.4	58.4	91.6	55.1	2.01	4.81	.33	.68	3.57	0	0	0
September	77.3	47.8	82.4	43.5	1.25	4.48	.04	.29	2.44	0	(2)	(2)
October	65.1	37.4	71.0	33.1	1.02	3.68	.04	.29	2.19	0	(2)	(2)
November	47.0	23.3	54.1	18.0	.42	2.24	0	.14	1.08	3	1	6
December	38.1	16.3	43.6	11.1	.22	1.22	.01	.07	.49	3	1	10
Year	60.5	34.8	67.4	29.5	16.59	[3] 25.85	[4] 9.82	12.04	21.49	29	11	54

[1] Prepared in part by WILLIAM F. LYTLE, South Dakota State University.
[2] Less than 0.5 day.
[3] In 1942.
[4] In 1940.

is 32 inches. During the period from 1934 through 1963 the seasonal snowfall varied from 84 inches in 1935-36 to 13 inches in 1950-51. The greatest snowfall in one day was 10.4 inches reported on January 27, 1944. The greatest monthly total was 27.5 inches in February 1936. Snow cover of 1 inch or more was on the ground for an average 54 days per year and ranged from 15 days during the winter of 1961-62 to 91 days during the winter of 1952-53. Strong winds often accompany snow and cause drifts in and near sheltered areas, though open areas may be nearly bare.

Although data on sunshine, wind, and humidity are not compiled at Martin, data taken at Valentine, Nebr., can be used to estimate averages of these factors of weather in Bennett County.

In an average year, sunshine can be expected about two-thirds of the daylight hours during the growing season and about three-fourths of the daylight hours in July and August, the sunniest months.

Winds average 10 to 11 miles an hour in summer, and the prevailing direction is from the southeast. During winter, winds average 11 to 12 miles an hour and the prevailing direction is from the northwest. Winds of 50 miles an hour or more may occur during any month but are most likely in summer months during thunderstorms. Thunderstorms occur on an average of about 11 days per month in June and July, 9 in August, 8 in May, and 4 in September. They are fewer in other months, and the annual average is 40 to 45 days. Hailstorms can be expected at Martin about once in 2 years, mostly in June.

The relative humidity in Bennett County has a wide daily variation from early in the morning to afternoon and, occasionally, a wide day-to-day variation. The average annual humidity is about 80 percent early in the morning and about 50 percent in the afternoon.

The potential water loss from soil, pastures, and crops is indicated by evaporation from a pan 4 feet in diameter. In Bennett County the average annual evaporation from the Weather Bureau class A pan is about 58 inches. An average of about 45 inches evaporates during May through October. The evaporation from small lakes is about 70 percent of the rate of pan evaporation. The water loss from soil and crops generally is less than the loss from lakes and depends on the available soil moisture.

Farming and Ranching

The only farming in Bennett County before it was opened to white settlers in 1910 was on small tracts cultivated by Indians who owned allotment land. The main enterprise was cattle ranching. Large acreages were used for grazing by cattle ranchers who headquartered out of the reservation. The acreage in cropland gradually increased after the first white settlers arrived, but the big increase in cropland and in the number of farms took place after 1920. Until 1940, many of the farms were small,

diversified, and of the family type. A variety of crops common to the more humid areas to the east were produced by farming methods used in those areas. Drought, grasshoppers, and the economic conditions in the 1930's contributed to the failure of this type of agriculture.

Dryland wheat farming in the Keith-Rosebud soil association and cattle ranching in the Oglala-Canyon and Valentine soil associations are now the main agricultural enterprises.

Number, size, and types of farms.—The total area of the county as reported by the 1964 Census of Agriculture is 760,960 acres. Of this acreage, land in farms makes up about 98 percent. The rest is in towns and villages, roads and highways, cemeteries, airports, water areas, and the Federal migratory waterfowl refuge. In 1964, 318 farms were in the county and the average-size farm was 2,349 acres.

The present trend is toward fewer and larger farms. The average-size farm in Bennett County was 601 acres in 1929, when there were 831 farms. In 1939, there were 559 farms, but since then the number of farms has decreased steadily. Of the 318 farms in 1964, 90 were more than 1,000 acres in size and 74 were more than 2,000 acres. Only 35 farms are less than 260 acres in size.

According to the 1964 census, the county had 93 cash-grain farms, 172 livestock farms, 24 livestock ranches, and 22 general farms. Most of the cash-grain farms are in the Keith-Rosebud association.

The 1964 census classified 292 farms and ranches as commercial because they were the main source of income to the operator.

Livestock.—The 1964 census reported 44,479 cattle, 8,490 hogs and pigs, 3,118 sheep and lambs, and 6,293 chickens on farms and ranches in the county. Cattle were reported on 246 farms, hogs on 88 farms, and sheep on 24 farms.

Annual reports of South Dakota Agricultural Statistics (*16*) from 1924 to 1965 show an increase in number of cattle and a decrease in hogs, sheep, horses and mules, and chickens. Hogs reached a peak of 19,800 in 1928 and since 1935 have fluctuated between 2,000 and 7,500. Sheep reached 29,600 in 1932 and have fluctuated between 3,500 and 7,500 since 1946. There were 7,600 horses and mules in 1925, but their decrease has been steady since then. Chickens reached a peak of 48,400 in 1944 but have been less than 20,000 since 1952. Only 13,900 cattle were reported in 1925. The number of cattle has gradually increased; 52,000 head were on farms and ranches in January 1, 1966. Most of the cattle are held for beef production.

Crops.—The main crops are winter wheat, alfalfa, corn, barley, oats, and rye. The 1964 census reported acreages of harvested crops as winter wheat, 42,028 acres; alfalfa and alfalfa mixtures for hay, 27,243 acres; corn, 2,895 acres; barley, 4,453 acres; oats, 12,141 acres; and rye, 2,630 acres. Small acreages were in spring wheat, sorghums, flax, and safflower. Alfalfa seed was harvested from 3,046 acres. In summer fallow were 59,151 acres.

Annual reports of South Dakota Agricultural Statistics from 1924 to 1965 reflect the evolution of agriculture in Bennett County from general farming to the present degree of specialization.

Since 1931, winter wheat generally has been planted on more than 30,000 acres. It was not until the 1940's, however, when summer fallow became common practice, that the county began consistently to produce winter wheat as a main crop. The largest acreage planted to winter wheat was 54,800 acres in 1952; the greatest production was 1,617,000 bushels harvested from 46,200 acres in 1957; and the highest average yield was 36 bushels per acre in 1958. Yields averaged 24.6 bushels per acre for the years 1951-65.

Durum wheat was briefly an important crop in the years 1927-30, but since 1933 less than 2,000 acres per year has been planted. The peak production of other spring wheat was reached in 1928 when 432,700 bushels was harvested from 22,100 acres for a yield of 19.6 bushels per acre. Although 1933 was the last year in which the acreage of spring wheat exceeded that of winter wheat, 34,800 acres was planted in 1948, and spring wheat remained an important crop through 1954. Since 1959, less than 1,000 acres has been planted to spring wheat. Spring wheat yields averaged 13.6 bushels per acre for the years 1951-65.

Until 1935, corn was the main crop in the county, and in some years its acreage exceeded the combined acreages of winter and spring wheat. Peak production of corn was in 1932 when 916,300 bushels was harvested from 59,500 acres. Since 1956, less than 10,000 acres has been planted to corn annually. Much of the corn now is used for silage and forage, and less than half of it is harvested for grain. The highest corn yield was in 1963 when 28 bushels per acre was the average yield. Yields in the county averaged 18.5 bushels per acre for the years 1951-65. The acreage in sorghum reached 14,500 acres in 1941 but since 1958 has been less than 1,500 acres per year.

The acreages of barley and oats have fluctuated greatly through the years. The years for record production of barley were 1929 and 1947 when 310,000 bushels was produced. The acreage in barley was largest in 1931, when 17,000 acres was planted. The highest barley yield for the county was 38.5 bushels per acre in 1965. The acreage in oats has fluctuated between a low of 4,900 acres in 1941 and a high of 14,000 acres in 1960. Total production was highest in 1928 when 415,400 bushels was harvested. The highest yield of oats was 44 bushels per acre in 1962. For the years 1951-65, barley yields averaged 23 bushels per acre and oat yields averaged 27 bushels per acre.

In 1942, 30,800 acres was planted to rye. Since 1948 the acreage has been less than 10,000. Yields of rye for the county averaged 29 bushels per acre in 1960, but the 1951-65 average was 17.1 bushels per acre.

Hay is an important crop in the county because it supports livestock enterprises. Harvested acreage of alfalfa hay reached 7,600 acres in 1930. Most of the stands failed to survive drought and grasshoppers in the 1930's. Since 1947, alfalfa hay has made a dramatic comeback. It occupied about 23,900 acres in 1964 and in 1965. Yields of alfalfa hay averaged 1.1 tons per acre for the years 1951-1965; the highest yield was 1.9 tons per acre in 1957. In recent years, other tame hay has averaged about 5,800 harvested acres, and the average yield is 1 ton per acre.

The acreage in wild hay has been reasonably consistent in the county, partly because natural subirrigated hay meadows are on Elsmere, Gannett, Lamo, and Loup soils. The largest acreage in wild hay was 52,500 acres in 1949. In recent years an average of 37,000 acres has been harvested, and the average yield has been 0.7 ton per acre.

In Bennett County agriculture has gradually become

an economy of wheat farms, farms with wheat and livestock enterprises, and cattle ranches. The small, diversified farms of 1920 to 1940 have disappeared. Winter wheat and alfalfa now are the main crops, and alfalfa seed is an important supplementary cash crop. In 1963, 5,700 acres of alfalfa was harvested for seed.

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Glossary

Alkali soil. Generally, a highly alkaline soil. Specifically, an alkali soil has so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchange sodium (15 percent or more of the total exchangeable bases), or both, that the growth of most crop plants is low from this cause.

Alluvium. Soil material, such as sand silt, or clay, that has been deposited on land by streams.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern.

Bearing capacity (engineering). The capacity of a soil to support loads. The verbal ratings of bearing capacity in this soil survey should not be given a value in pounds per square inch.

Blowout. An excavation produced by wind action in loose soil, usually sand.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Caliche. A more or less cemented deposit of calcium carbonate in many soils of warm-temperate areas, as in the Southwestern States. The material may consist of soft, thin layers in the soil or of hard, thick beds just beneath the solum, or it may be exposed at the surface by erosion.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Claypan. A compact, slowly permeable soil horizon that contains more clay than the horizon above and below it. A claypan is commonly hard when dry and plastic or stiff when wet.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds, or of soil grains cemented together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Diversion. A channel with a supporting ridge on the lower side constructed across the slope.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by wind (sandblast), running water, and other geological agents.

Fertility, soil. The quality of a soil that enables it to provide compounds, in adequate amounts and in proper balance, for the growth of specified plants, when other growth factors such as light, moisture, temperature, and the physical condition of the soil are favorable.

Gravel. Rounded or angular rock fragments that are not prominently flattened and are up to 3 inches in diameter.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

O horizon.—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon.—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of 1, 2, and 3. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

Leaching. The removal of soluble materials from soils or soil material by percolating water.

Loess. A fine-grained, wind-transported deposit consisting dominantly of silt-sized particles.

Mottled. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: Abundance—*few, common,* and *many;* size—*fine, medium,* and *coarse;* and contrast—*faint, distinct,* and *prominent.* The size measurements are these: *fine,* less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium,* ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse,* more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Permeability. The quality of a soil horizon that enables water or air to move through it. Terms used to describe permeability are as follows: *very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

pH value. A numerical means for designating relatively weak acidity and alkalinity in soils. A pH value of 7.0 indicates precise neutrality; a higher value alkalinity; and a lower value, acidity.

Pitting. Making shallow pits or basins of suitable capacity and distribution on rangeland to retain water from rainfall and snowmelt. (Does not include contour furrowing.)

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; and alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	pH		*pH*
Extremely acid	Below 4.5	Mildly alkaline	7.4 to 7.8
Very strongly acid	4.5 to 5.0	Moderately alkaline	7.9 to 8.4
Strongly acid	5.1 to 5.5	Strongly alkaline	8.5 to 9.0
Medium acid	5.6 to 6.0	Very strongly alkaline.	9.1 and higher
Slightly acid	6.1 to 6.5		
Neutral	6.6 to 7.3		

Runoff. The part of the precipitation upon a drainage area that is discharged from the area in stream channels. The water that flows off land surface without sinking in is called surface runoff; that which enters the ground before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Saline soil. A soil that contains soluble salts in amounts that impair growth of plants but that does not contain excess exchangeable sodium.

Saline-alkali soil. A soil that contains a harmful concentration of salts and exchangeable sodium; or contains harmful salts and has a highly alkaline reaction; or contains harmful salts and exchangeable sodium and is strongly alkaline in reaction. The salts, exchangeable sodium, and alkaline reaction occur in the soil in such location that growth of most crop plants is less than normal.

Sand. Individual rock or mineral fragments in soils having diameters ranging from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Sequum. A sequence consisting of an illuvial horizon and the overlying eluvial horizon. If two sequa are present in a single soil profile, it is said to have a bisequum.

Shear strength (engineering). The maximum ability of a soil to resist shearing or sliding along internal surfaces within a mass.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are (1) *single grain* (each grain by itself, as in dune sand) or (2) *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. Technically the part of the soil below the solum.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surplus runoff so that it may soak into the soil or flow slowly to a prepared outlet without harm. Terraces in fields are generally built so they can be farmed. Terraces intended mainly for drainage have a deep channel that is maintained in permanent sod.

Texture, soil. The relative proportions of sand, silt and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Topsoil. A presumed fertile soil or soil material, or one that responds to fertilization, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

Water-holding capacity. The capacity of a soil to hold water in a form available to plants. The amount of moisture held in soil between field capacity, or about one-third atmosphere of tension, and the wilting point, or about 15 atmospheres of tension.

Wilting point (or permanent wilting point). The moisture content of soil on an oven-dry basis, at which plants (specifically sunflower) wilt so much that they do not recover when placed in a dark, humid atmosphere.

GUIDE TO MAPPING UNITS

For complete information about a mapping unit, read both the description of the mapping unit and that of the soil series to which the mapping unit belongs. A technical description of a profile that is representative of the series is part of each series description. For complete information about a capability unit, read the introduction "Management of Cropland," which gives general information about management. For information about managing the soils for wildlife, see page 54. Other information is given in tables as follows:

Acreage and extent, table 1, page 7.
Predicted yields, table 2, page 51.
Engineering uses of soils, tables 4, 5, 6, and 7, page 58 through page 67

Map symbol	Mapping unit	Page	Range site Name	Range site Page	Capability unit Symbol	Capability unit Page	Windbreak suitability group Number	Windbreak suitability group Page
Aa	Alluvial land	8	Subirrigated	39	VIw-1	49	3	53
AlB	Altvan loam, 0 to 5 percent slopes	8	Silty	42	IIIs-2	48	2	52
AnB	Anselmo fine sandy loam, 0 to 5 percent slopes	9	Sandy	41	IIIe-2	48	1	52
AtE	Anselmo-Tassel complex, 9 to 18 percent slopes	9						
	Anselmo soil	--	Sandy	41	VIe-1	49	1	52
	Tassel soil	--	Shallow	42	VIs-2	50	(1/)	--
Bk	Bankard loamy fine sand	11	Sands	41	VIe-2	49	1	52
Bo	Blown-out land	11	Sands	41	VIe-2	49	6	54
CnF	Canyon complex, 18 to 40 percent slopes	11						
	Canyon soil	--	Shallow	42	VIIs-1	50	(1/)	--
	Rock outcrop	--	(1/)	--	VIIIs-1	50	(1/)	--
CoF	Canyon-Oglala complex, 18 to 40 percent slopes	12						
	Canyon soil	--	Shallow	42	VIIs-1	50	(1/)	--
	Oglala soil	--	Silty	42	VIe-1	49	2	52
Cr	Canyon-Rock outcrop complex	12						
	Canyon soil	--	Shallow	42	VIIs-1	50	(1/)	--
	Rock outcrop	--	(1/)	--	VIIIs-1	50	(1/)	--
CyD2	Canyon-Rosebud complex, 3 to 12 percent slopes, eroded	13						
	Canyon soil	--	Shallow	42	VIs-2	50	(1/)	--
	Rosebud soil	--	Silty	42	IIIe-1	47	2	52
DkA	Dawes-Keith complex, 0 to 3 percent slopes	15						
	Dawes soil	--	Silty	42	IIIs-1	48	4	53
	Keith soil	--	Silty	42	IIc-1	47	2	52
DrB	Dawes-Richfield silt loams, 0 to 5 percent slopes	15						
	Dawes soil	--	Silty	42	IIIs-1	48	4	53
	Richfield soil	--	Silty	42	IIc-1	47	2	52
DsB	Dunday loamy fine sand, 0 to 6 percent slopes	15	Sandy	41	IVe-3	48	1	52
DtA	Dunday-Anselmo complex, 0 to 3 percent slopes	16						
	Dunday soil	--	Sandy	41	IVe-3	48	1	52
	Anselmo soil	--	Sandy	41	IIIe-2	48	1	52
DtC	Dunday-Anselmo complex, 3 to 9 percent slopes	16						
	Dunday soil	--	Sandy	41	VIe-2	49	1	52
	Anselmo soil	--	Sandy	41	IIIe-2	48	1	52
Du	Dunday and Elsmere loamy fine sands	16						
	Dunday soil	--	Sandy	41	IVe-3	48	1	52
	Elsmere soil	--	Subirrigated	39	IVw-1	49	3	53
DvB	Dunday-Valentine complex, 0 to 5 percent slopes	16						
	Dunday soil	--	Sandy	41	IVe-3	48	1	52
	Valentine soil	--	Sands	41	VIe-2	49	6	54

See footnote at end of guide.

Map symbol	Mapping unit	Page	Range site: Name	Range site: Page	Capability unit: Symbol	Capability unit: Page	Windbreak suitability group: Number	Windbreak suitability group: Page
EhF	Epping complex, 9 to 40 percent slopes-----	17						
	Epping soil---------------------------	--	Shallow	42	VIs-2	50	(1/)	--
	Kadoka soil---------------------------	--	Silty	42	VIe-1	49	2	52
Ga	Gannett fine sandy loam-------------------	18	Wetland	39	Vw-1	49	3	53
GoA	Goshen silt loam, 0 to 3 percent slopes----	19	Overflow	40	IIc-1	47	2	52
GoB	Goshen silt loam, 3 to 6 percent slopes----	19	Silty	42	IIe-1	47	2	52
Gr	Gravelly land-----------------------------	19	Shallow	42	VIIs-1	50	(1/)	--
HaA	Haverson loam, 0 to 3 percent slopes-------	20	Overflow	40	IIw-1	47	2	52
HtB	Holt and Tuthill fine sandy loams, 0 to 5 percent slopes--------------------------	21	Sandy	41	IIIe-2	48	1	52
HtC	Holt and Tuthill fine sandy loams, 5 to 9 percent slopes--------------------------	21	Sandy	41	IVe-2	48	1	52
Hv	Hoven silt loam---------------------------	22	Closed Depression	40	VIs-1	49	(1/)	--
KaB	Kadoka silt loam, 3 to 5 percent slopes----	23	Silty	42	IIe-1	47	2	52
KeA	Keith silt loam, 0 to 3 percent slopes-----	24	Silty	42	IIc-1	47	2	52
KeB	Keith silt loam, 3 to 5 percent slopes-----	24	Silty	42	IIe-1	47	2	52
KhD	Keith-Colby silt loams, 9 to 12 percent slopes----------------------------------	24						
	Keith soil----------------------------	--	Silty	42	IVe-1	48	2	52
	Colby soil----------------------------	--	Thin Upland	42	IVe-1	48	2	52
KrA	Keith-Rosebud silt loams, 0 to 2 percent slopes----------------------------------	24	Silty	42	IIc-1	47	2	52
KrB	Keith-Rosebud silt loams, 2 to 6 percent slopes----------------------------------	25	Silty	42	IIe-1	47	2	52
KuC	Keith and Ulysses silt loams, 5 to 9 percent slopes----------------------------	25	Silty	42	IIIe-1	47	2	52
La	Lamo silt loam----------------------------	26	Subirrigated	39	Vw-1	49	3	53
Lo	Loup fine sandy loam----------------------	27	Subirrigated	39	Vw-1	49	3	53
Ma	Marsh-------------------------------------	27	(1/)	--	VIIIw-1	50	(1/)	--
Me	Minatare soils----------------------------	28	Saline Lowland	39	VIs-1	49	5	53
Mm	Mosher-Minatare complex-------------------	28						
	Mosher soil---------------------------	--	Claypan	42	IVs-1	49	4	53
	Minatare soil-------------------------	--	Saline Lowland	39	VIs-1	49	5	53
OcE	Oglala-Canyon complex, 9 to 18 percent slopes----------------------------------	29						
	Oglala soil---------------------------	--	Silty	42	VIe-1	49	2	52
	Canyon soil---------------------------	--	Shallow	42	VIs-2	50	(1/)	--
OrA	Oglala-Rosebud silt loams, 0 to 3 percent slopes----------------------------------	29	Silty	42	IIc-1	47	2	52
OrB	Oglala-Rosebud silt loams, 3 to 6 percent slopes----------------------------------	30	Silty	42	IIe-1	47	2	52
RkA	Richfield and Keith silt loams, 0 to 2 percent slopes----------------------------	30	Silty	42	IIc-1	47	2	52
RkB	Richfield and Keith silt loams, 2 to 6 percent slopes----------------------------	31	Silty	42	IIe-1	47	2	52
TaF	Tassel-Anselmo complex, 18 to 40 percent slopes----------------------------------	32						
	Tassel soil---------------------------	--	Shallow	42	VIIs-1	50	(1/)	--
	Anselmo soil--------------------------	--	Sandy	41	VIe-1	49	1	52
TnB	Tuthill and Anselmo fine sandy loams, 0 to 5 percent slopes-----------------------	34	Sandy	41	IIIe-2	48	1	52
TnC	Tuthill and Anselmo fine sandy loams, 5 to 9 percent slopes-----------------------	34	Sandy	41	IVe-2	48	1	52
VaC	Valentine fine sand, rolling--------------	35	Sands	41	VIe-2	49	6	54

See footnote at end of guide.

Map symbol	Mapping unit	Page	Range site: Name	Range site: Page	Capability unit: Symbol	Capability unit: Page	Windbreak suitability group: Number	Windbreak suitability group: Page
VaD	Valentine fine sand, hilly	35	Choppy Sands	42	VIIe-1	50	6	54
VeD	Valentine-Tassel complex, hilly	37						
	Valentine soil	--	Sands	41	VIe-2	49	6	54
	Tassel soil	--	Shallow	42	VIIs-1	50	(1/)	--
VgA	Vetal and Goshen soils, 0 to 3 percent slopes	37						
	Vetal soil	--	Sandy	41	IIIe-2	48	1	52
	Goshen soil	--	Overflow	40	IIc-1	47	2	52
VhD	Vetal-Holt fine sandy loams, 6 to 15 percent slopes	37	Sandy	41	------	--	1	52
	6 to 9 percent slopes	--	--------	--	IVe-2	48		
	9 to 15 percent slopes	--	--------	--	VIe-1	49		

1/ Not suitable.

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program information (e.g., Braille, large print, audiotape, etc.), please contact USDA's TARGET Center at (202) 720-2600 (voice and TDD).

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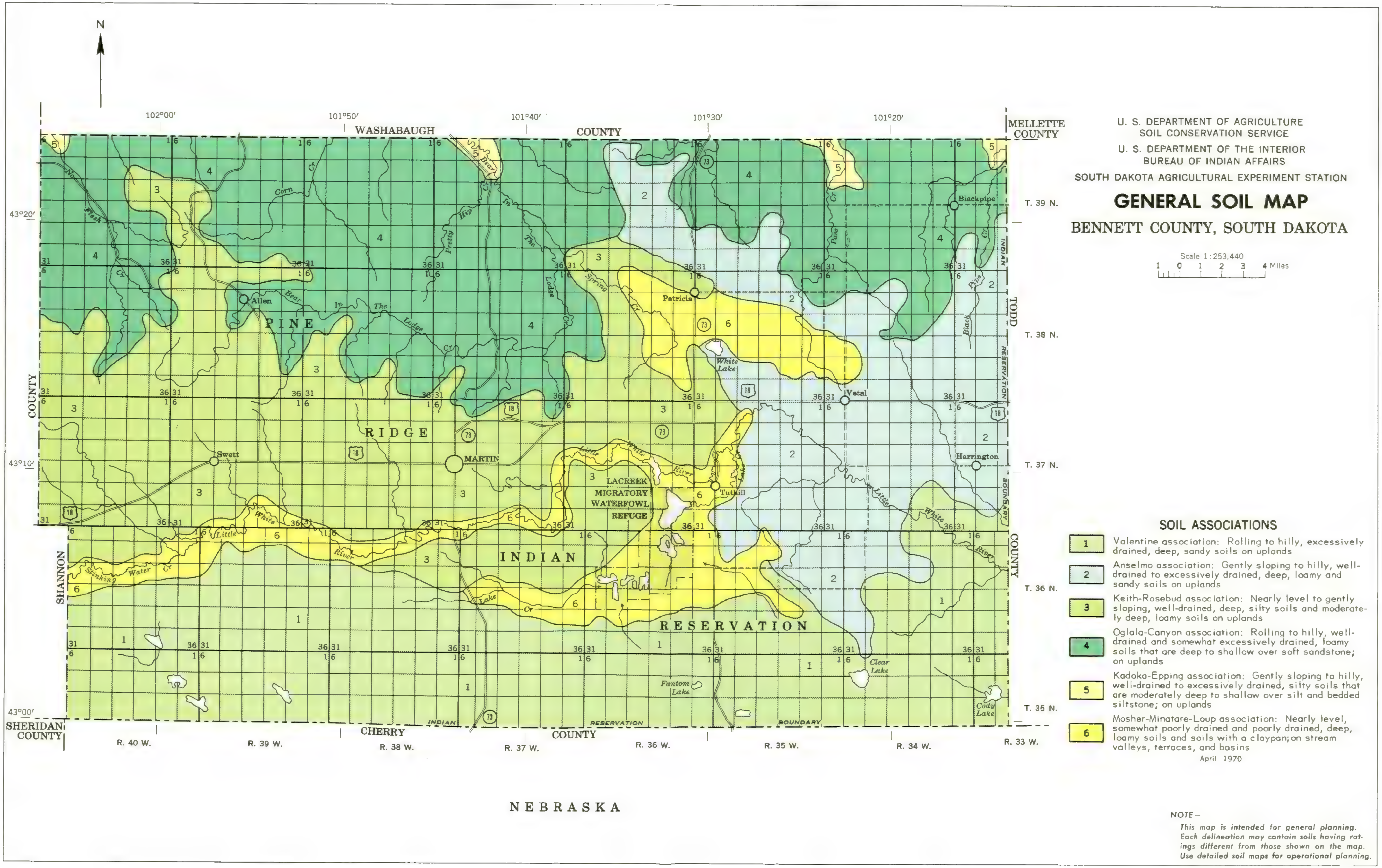
For additional information dealing with Supplemental Nutrition Assistance Program (SNAP) issues, call either the USDA SNAP Hotline Number at (800) 221-5689, which is also in Spanish, or the State Information/Hotline Numbers (http://directives.sc.egov.usda.gov/33085.wba).

All Other Inquiries

For information not pertaining to civil rights, please refer to the listing of the USDA Agencies and Offices (http://directives.sc.egov.usda.gov/33086.wba).

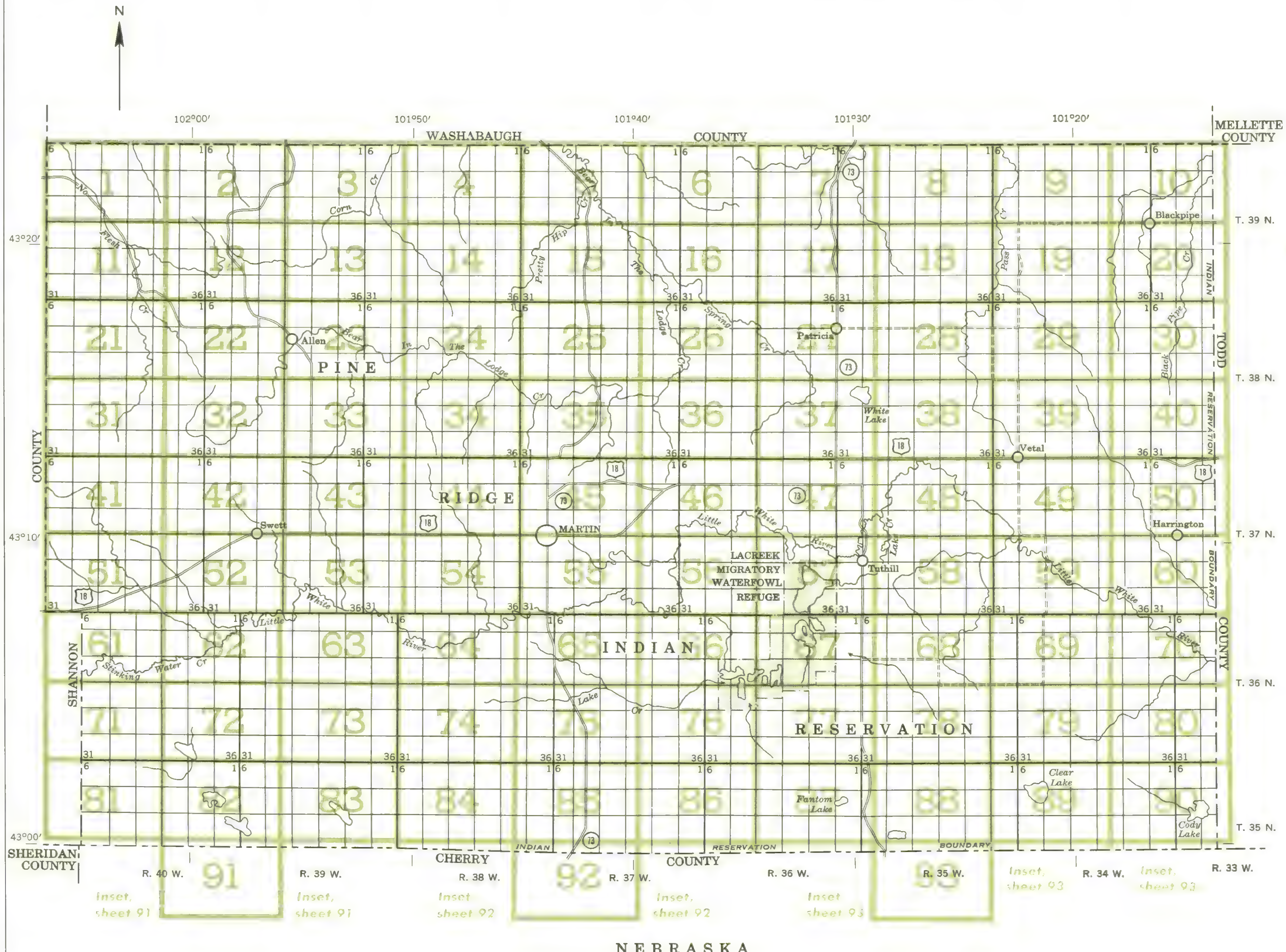


U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
U. S. DEPARTMENT OF THE INTERIOR
BUREAU OF INDIAN AFFAIRS
SOUTH DAKOTA AGRICULTURAL EXPERIMENT STATION
GENERAL SOIL MAP
BENNETT COUNTY, SOUTH DAKOTA
Scale 1:253,440
1 0 1 2 3 4 Miles
SOIL ASSOCIATIONS
1 Valentine association: Rolling to hilly, excessively drained, deep, sandy soils on uplands
2 Anselmo association: Gently sloping to hilly, well-drained to excessively drained, deep, loamy and sandy soils on uplands
3 Keith-Rosebud association: Nearly level to gently sloping, well-drained, deep, silty soils and moderately deep, loamy soils on uplands
4 Oglala-Canyon association: Rolling to hilly, well-drained and somewhat excessively drained, loamy soils that are deep to shallow over soft sandstone; on uplands
5 Kadoka-Epping association: Gently sloping to hilly, well-drained to excessively drained, silty soils that are moderately deep to shallow over silt and bedded siltstone; on uplands
6 Mosher-Minatare-Loup association: Nearly level, somewhat poorly drained and poorly drained, deep, loamy soils and soils with a claypan; on stream valleys, terraces, and basins
April 1970
NOTE –
This map is intended for general planning. Each delineation may contain soils having ratings different from those shown on the map. Use detailed soil maps for operational planning.
WASHABAUGH COUNTY
MELLETTE COUNTY
TODD COUNTY
SHANNON COUNTY
SHERIDAN COUNTY
CHERRY COUNTY
NEBRASKA
PINE RIDGE INDIAN RESERVATION
INDIAN RESERVATION BOUNDARY
LACREEK MIGRATORY WATERFOWL REFUGE
MARTIN
Allen
Swett
Patricia
Vetal
Tuthill
Blackpipe
Harrington
White Lake
Clear Lake
Fantom Lake
Cody Lake
Little White River
White River
Bear In The Lodge Cr
Stinking Water Cr
Lake Cr
Spring Cr
Black Pipe Cr
Corn Cr
T. 39 N.
T. 38 N.
T. 37 N.
T. 36 N.
T. 35 N.
R. 40 W.
R. 39 W.
R. 38 W.
R. 37 W.
R. 36 W.
R. 35 W.
R. 34 W.
R. 33 W.
102°00′
101°50′
101°40′
101°30′
101°20′
43°20′
43°10′
43°00′
N

INDEX TO MAP SHEETS

BENNETT COUNTY, SOUTH DAKOTA

Scale 1:253,440



SOIL LEGEND

The first capital letter is the initial one of the soil name. A second capital letter, A, B, C, D, E, or F, shows the slope. Most symbols without a slope letter are those of soils or land types that are nearly level, but some are for soils and land types that have a considerable range in slope. The number, 2, in the symbol shows that the soil is eroded.

SYMBOL	NAME
Aa	Alluvial land
AlB	Altvan loam, 0 to 5 percent slopes
AnB	Anselmo fine sandy loam, 0 to 5 percent slopes
AtE	Anselmo-Tassel complex, 9 to 18 percent slopes
Bk	Bankard loamy fine sand
Bo	Blown-out land
CnF	Canyon complex, 18 to 40 percent slopes
CoF	Canyon-Oglala complex, 18 to 40 percent slopes
Cr	Canyon-Rock outcrop complex
CyD2	Canyon-Rosebud complex, 3 to 12 percent slopes, eroded
DkA	Dawes-Keith complex, 0 to 3 percent slopes
DrB	Dawes-Richfield silt loams, 0 to 5 percent slopes
DsB	Dunday loamy fine sand, 0 to 6 percent slopes
DtA	Dunday-Anselmo complex, 0 to 3 percent slopes
DtC	Dunday-Anselmo complex, 3 to 9 percent slopes
Du	Dunday and Elsmere loamy fine sands
DvB	Dunday-Valentine complex, 0 to 5 percent slopes
EhF	Epping complex, 9 to 40 percent slopes
Ga	Gannett fine sandy loam
GoA	Goshen silt loam, 0 to 3 percent slopes
GoB	Goshen silt loam, 3 to 6 percent slopes
Gr	Gravelly land
HaA	Haverson loam, 0 to 3 percent slopes
HtB	Holt and Tuthill fine sandy loams, 0 to 5 percent slopes
HtC	Holt and Tuthill fine sandy loams, 5 to 9 percent slopes
Hv	Hoven silt loam
KaB	Kadoka silt loam, 3 to 5 percent slopes
KeA	Keith silt loam, 0 to 3 percent slopes
KeB	Keith silt loam, 3 to 5 percent slopes
KnD	Keith-Colby silt loams, 9 to 12 percent slopes
KrA	Keith-Rosebud silt loams, 0 to 2 percent slopes
KrB	Keith-Rosebud silt loams, 2 to 6 percent slopes
KuC	Keith and Ulysses silt loams, 5 to 9 percent slopes
La	Lamo silt loam
Lo	Loup fine sandy loam
Ma	Marsh
Me	Minatare soils
Mm	Mosher-Minatare complex
OcE	Oglala-Canyon complex, 9 to 18 percent slopes
OrA	Oglala-Rosebud silt loams, 0 to 3 percent slopes
OrB	Oglala-Rosebud silt loams, 3 to 6 percent slopes
RkA	Richfield and Keith silt loams, 0 to 2 percent slopes
RkB	Richfield and Keith silt loams, 2 to 6 percent slopes
TaF	Tassel-Anselmo complex, 18 to 40 percent slopes
TnB	Tuthill and Anselmo fine sandy loams, 0 to 5 percent slopes
TnC	Tuthill and Anselmo fine sandy loams, 5 to 9 percent slopes
VaC	Valentine fine sand, rolling
VaD	Valentine fine sand, hilly
VeD	Valentine-Tassel complex, hilly
VgA	Vetal and Goshen soils, 0 to 3 percent slopes
VhD	Vetal-Holt fine sandy loams, 6 to 15 percent slopes

CONVENTIONAL SIGNS

WOPKS AND STRUCTURES

Highways and roads
- Dual
- Good motor
- Poor motor
- Trail

Highway markers
- National Interstate
- U. S.
- State or county

Railroads
- Single track
- Multiple track
- Abandoned

Bridges and crossings
- Road
- Trail
- Railroad
- Ferry — FY
- Ford — FORD
- Grade
- R. R. over
- R. R. under

Tunnel

Buildings
- School
- Church

Mine and quarry

Gravel pit

Power line

Pipeline

Cemetery

Dams

Levee

Tanks

Well, oil or gas

Forest fire or lookout station

Windmill

BOUNDARIES

- National or state
- County
- Reservation
- Land grant
- Small park, cemetery, airport
- Land survey division corners

DRAINAGE

Streams, double-line
- Perennial
- Intermittent

Streams, single-line
- Perennial
- Intermittent
  - Crossable with tillage implements
  - Not crossable with tillage implements
  - Unclassified

Canals and ditches — CANAL

Lakes and ponds
- Perennial — water, w
- Intermittent — int

Spring

Marsh or swamp

Wet spot

Alluvial fan

Drainage end

RELIEF

Escarpments
- Bedrock
- Other

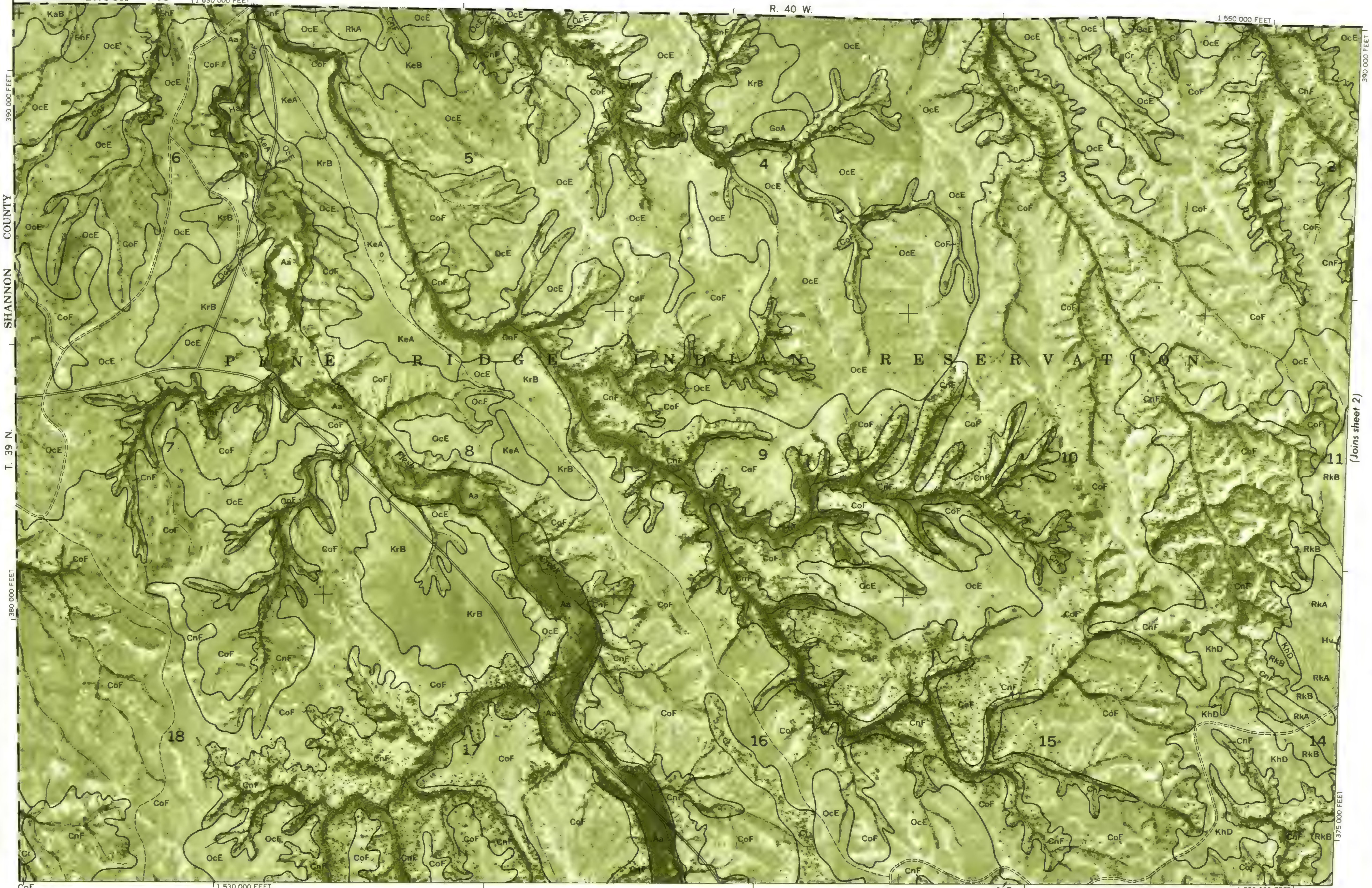
Prominent peak

Depression, unclassified — Large, Small

SOIL SURVEY DATA

- Soil boundary and symbol — Dx
- Gravel
- Stoniness
  - Stony
  - Very stony
- Rock outcrops
- Chert fragments
- Clay spot
- Sand spot
- Gumbo or scabby spot
- Made land
- Severely eroded spot
- Blowout, wind erosion
- Gully

Soil map constructed 1969 by Cartographic Division, Soil Conservation Service, USDA, from 1961 aerial photographs. Controlled mosaic based on South Dakota plane coordinate system, south zone, Lambert conformal conic projection, 1927 North American datum.



Bennett County line on this sheet overlaps slightly into Washabaugh County due to compilation from later data.

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station

BENNETT COUNTY, SOUTH DAKOTA NO. 1

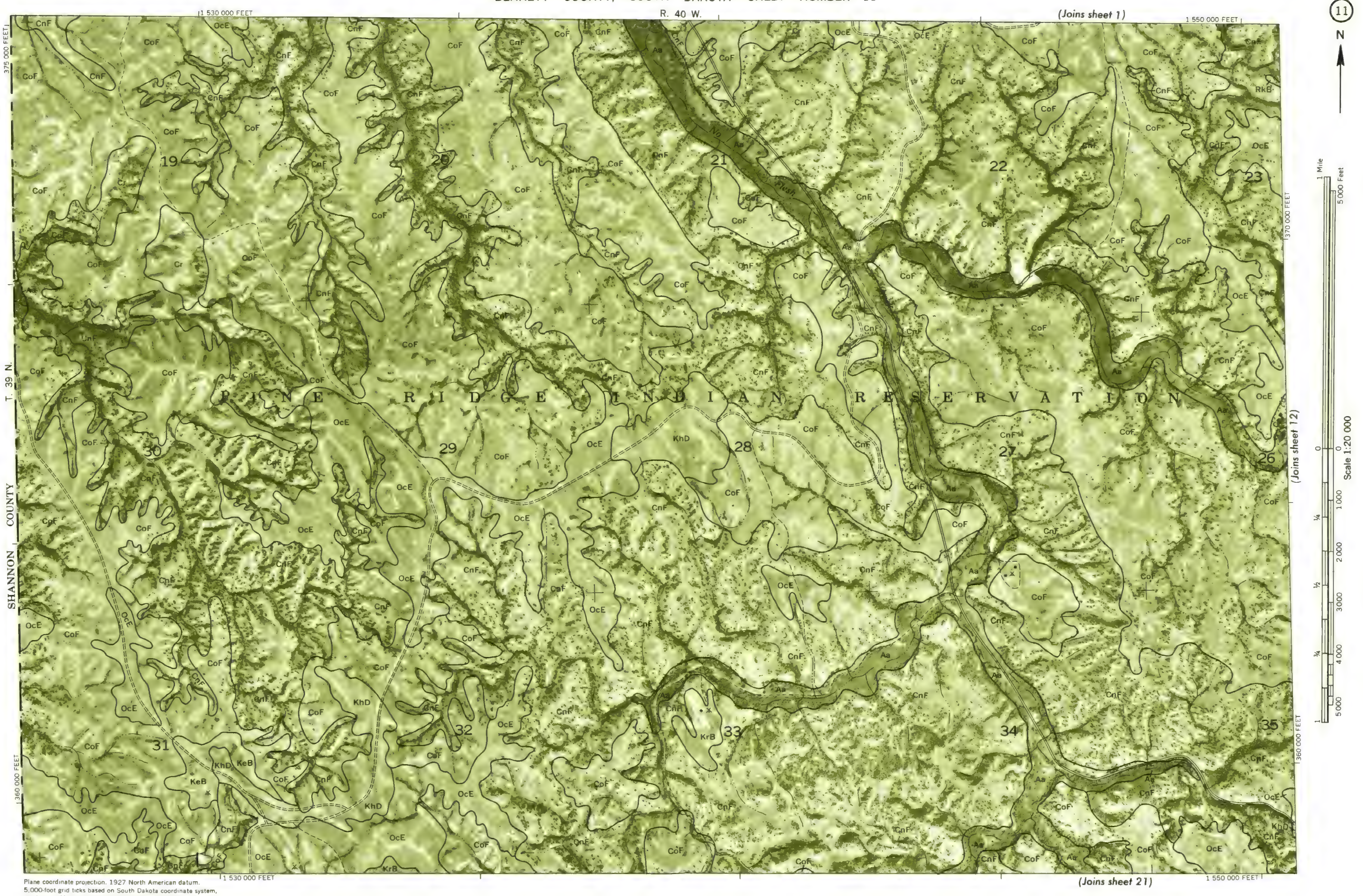
Plane coordinate projection. 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

Plane coordinate projection. 1927 North American datum. 5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

BENNETT COUNTY, SOUTH DAKOTA NO. 10

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.



This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

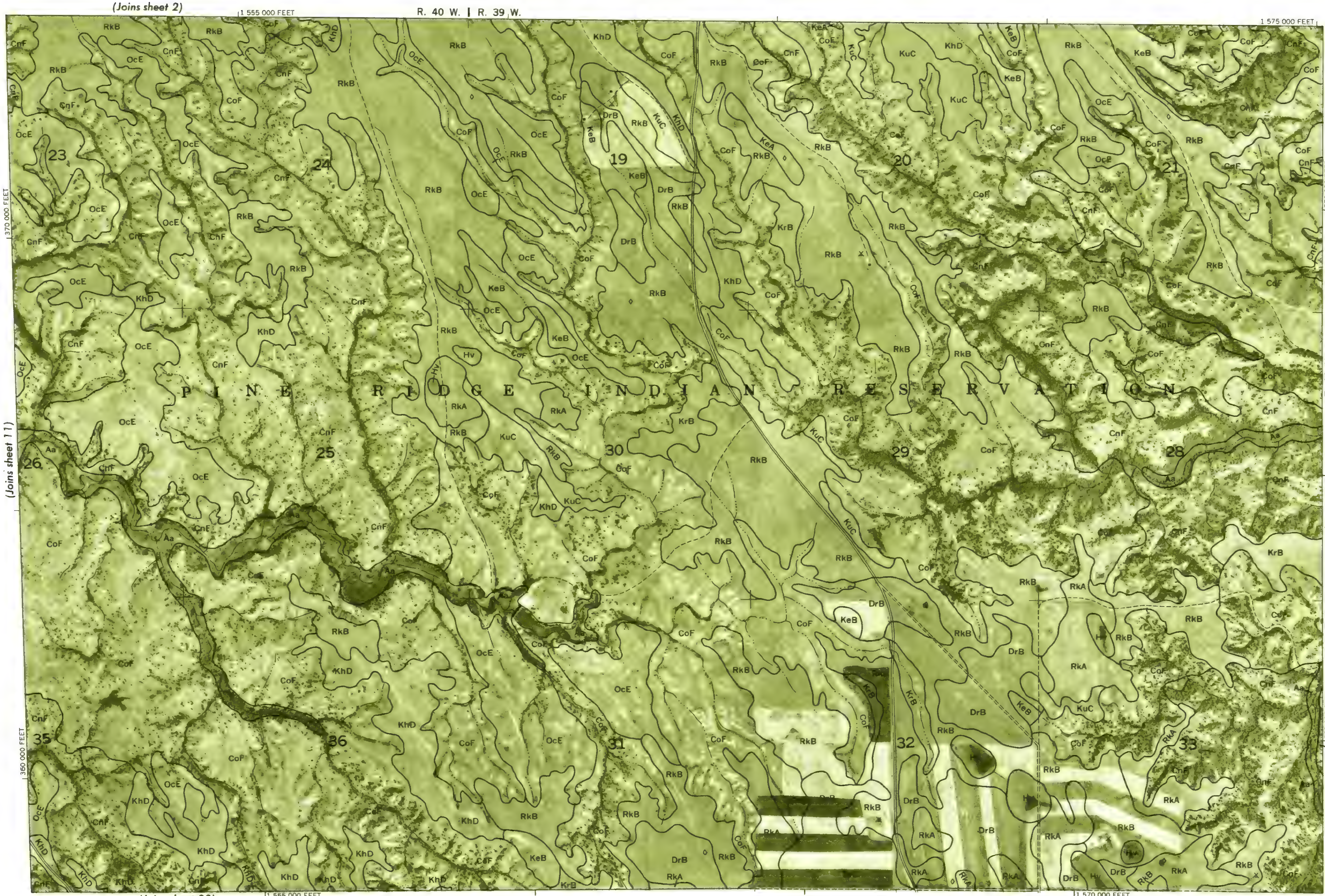
BENNETT COUNTY, SOUTH DAKOTA NO. 11

Plane coordinate projection. 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

12

N

(Joins sheet 2)



(Joins sheet 22)

1 Mile

5000 Feet

Scale 1:20 000

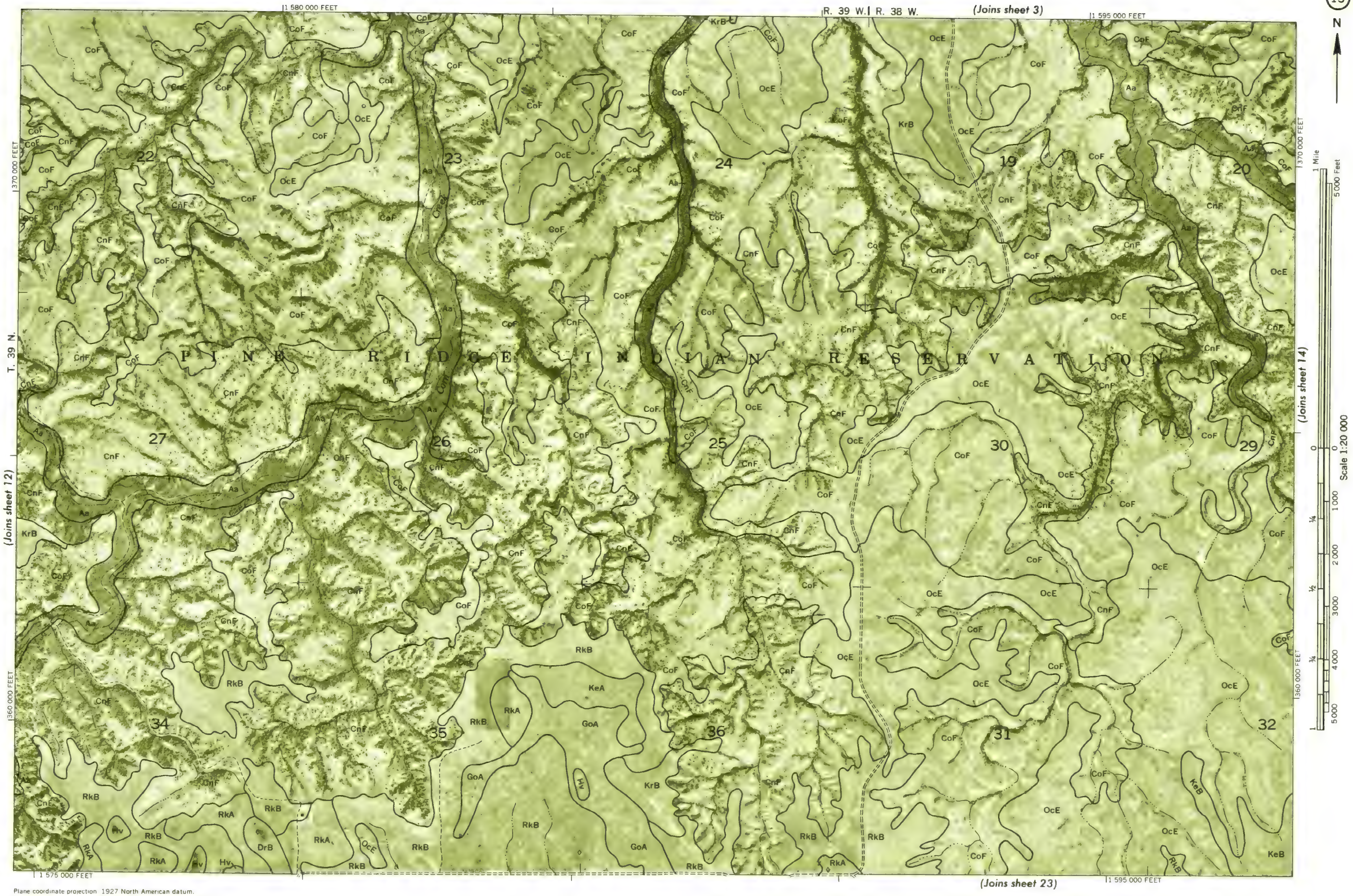
0 1000 2000 3000 4000 5000

0 ¼ ½ ¾ 1

Plane coordinate projection. 1927 North American datum. 5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

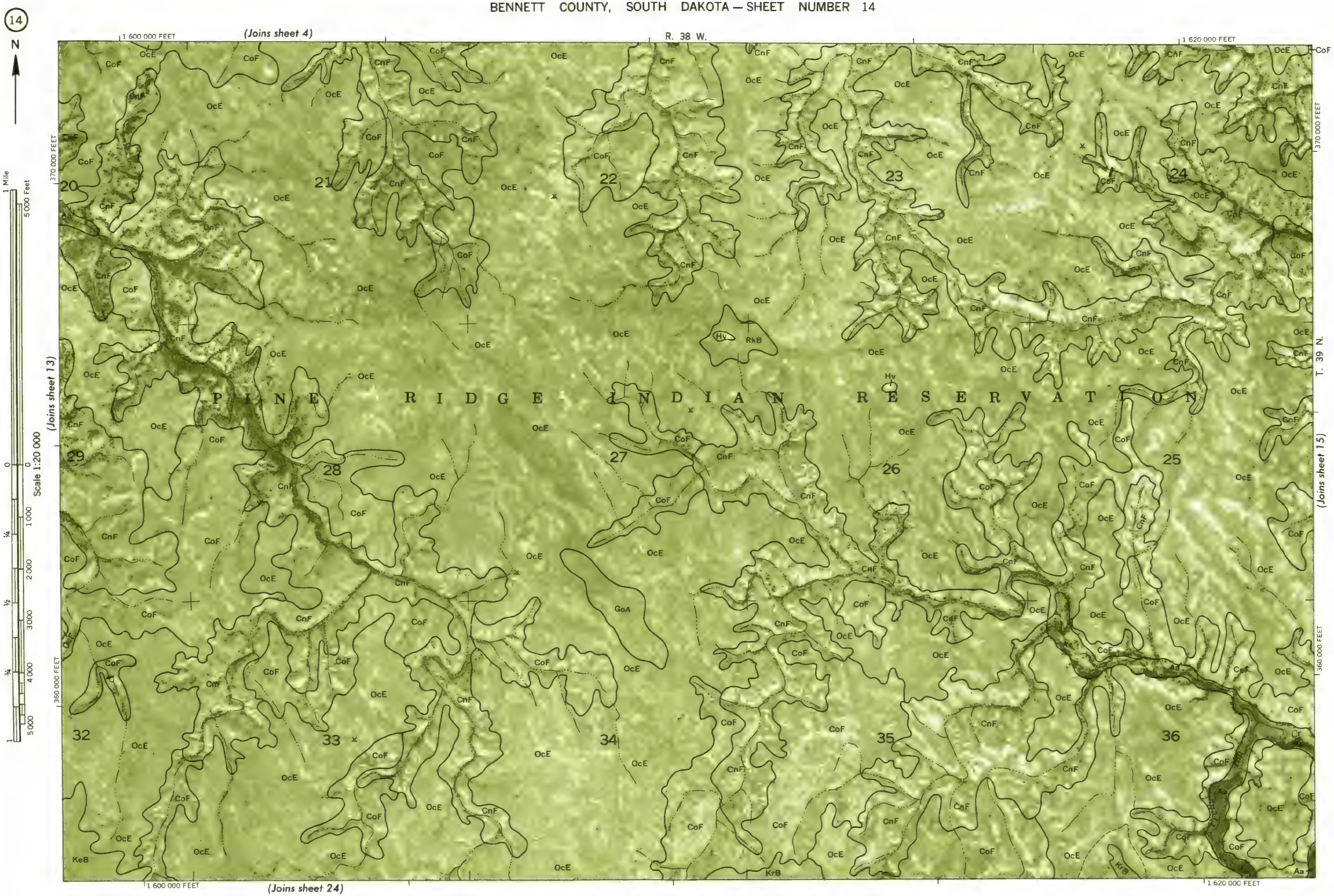
Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1965 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.



Plane coordinate projection 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs and the South Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

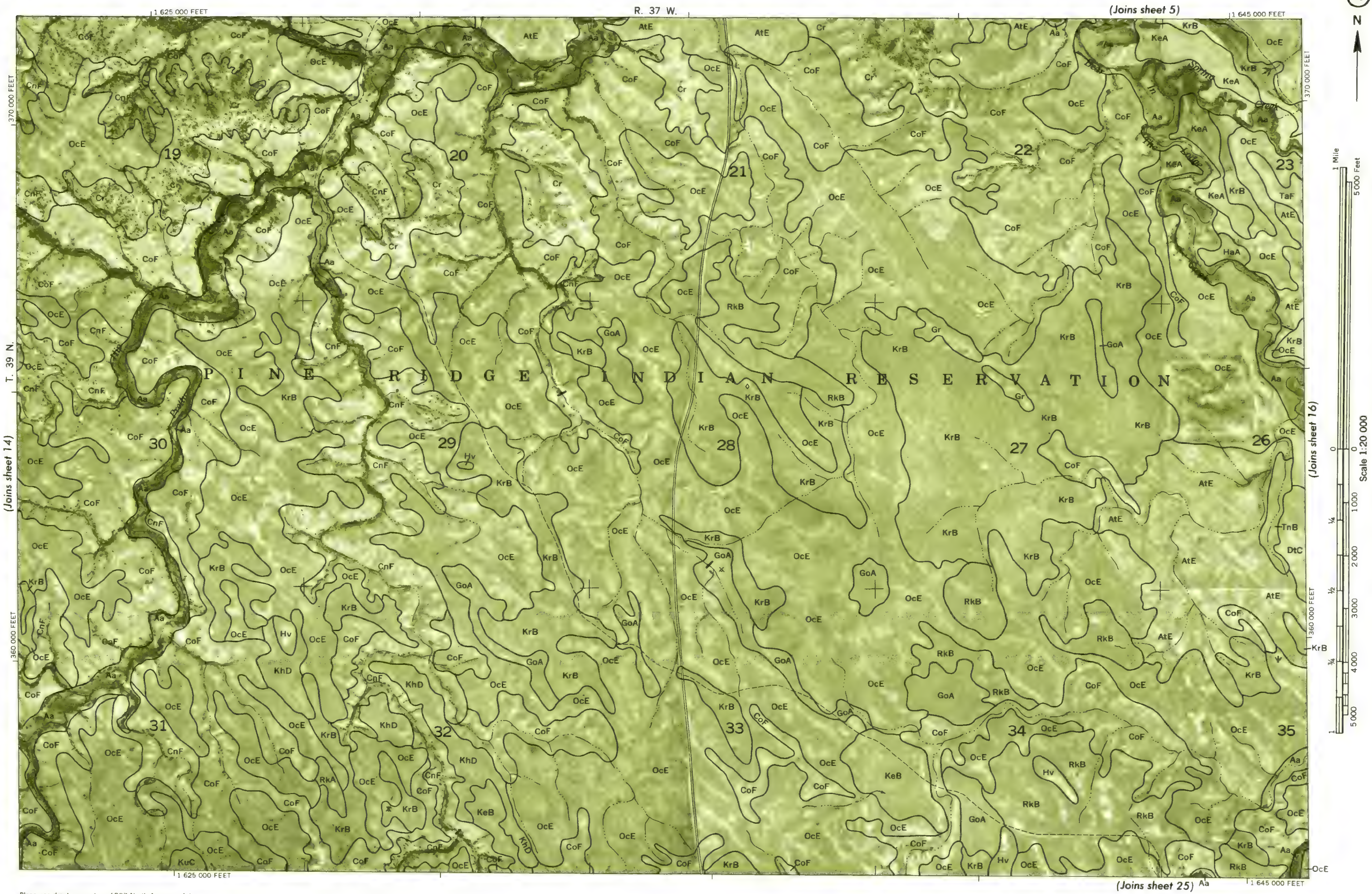


Plane coordinate projection. 1927 North American datum. 5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

BENNETT COUNTY, SOUTH DAKOTA NO. 14

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station

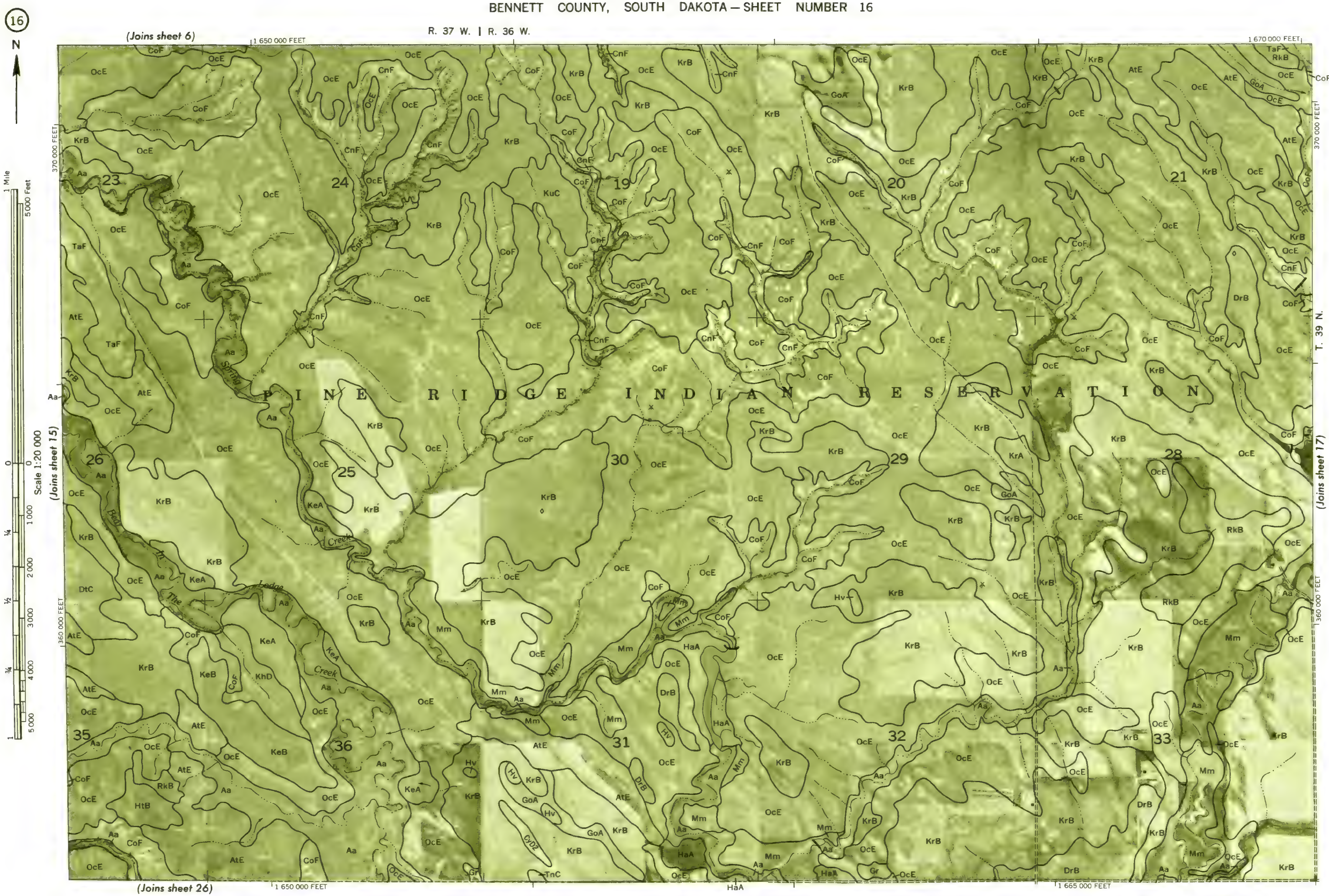


This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

BENNETT COUNTY, SOUTH DAKOTA NO. 15

Plane coordinate projection. 1927 North American datum
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

BENNETT COUNTY, SOUTH DAKOTA — SHEET NUMBER 16



Plane coordinate projection. 1927 North American datum. 5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

Land division corners are approximately positioned on this map.

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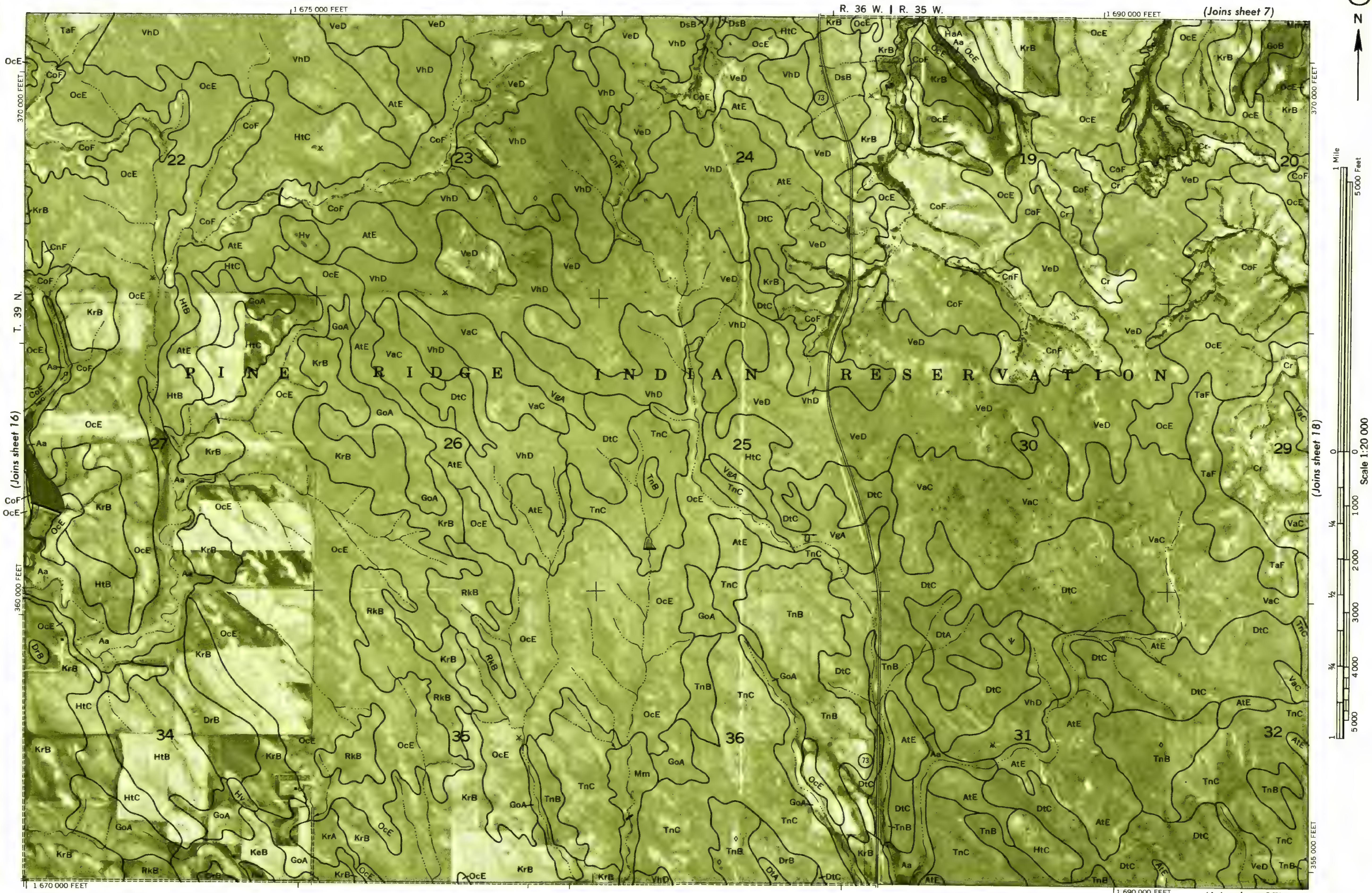
BENNETT COUNTY, SOUTH DAKOTA NO. 16

(17)



Plane coordinate projection. 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system,
south zone. Mosaic compiled from 1961 aerial photographs.

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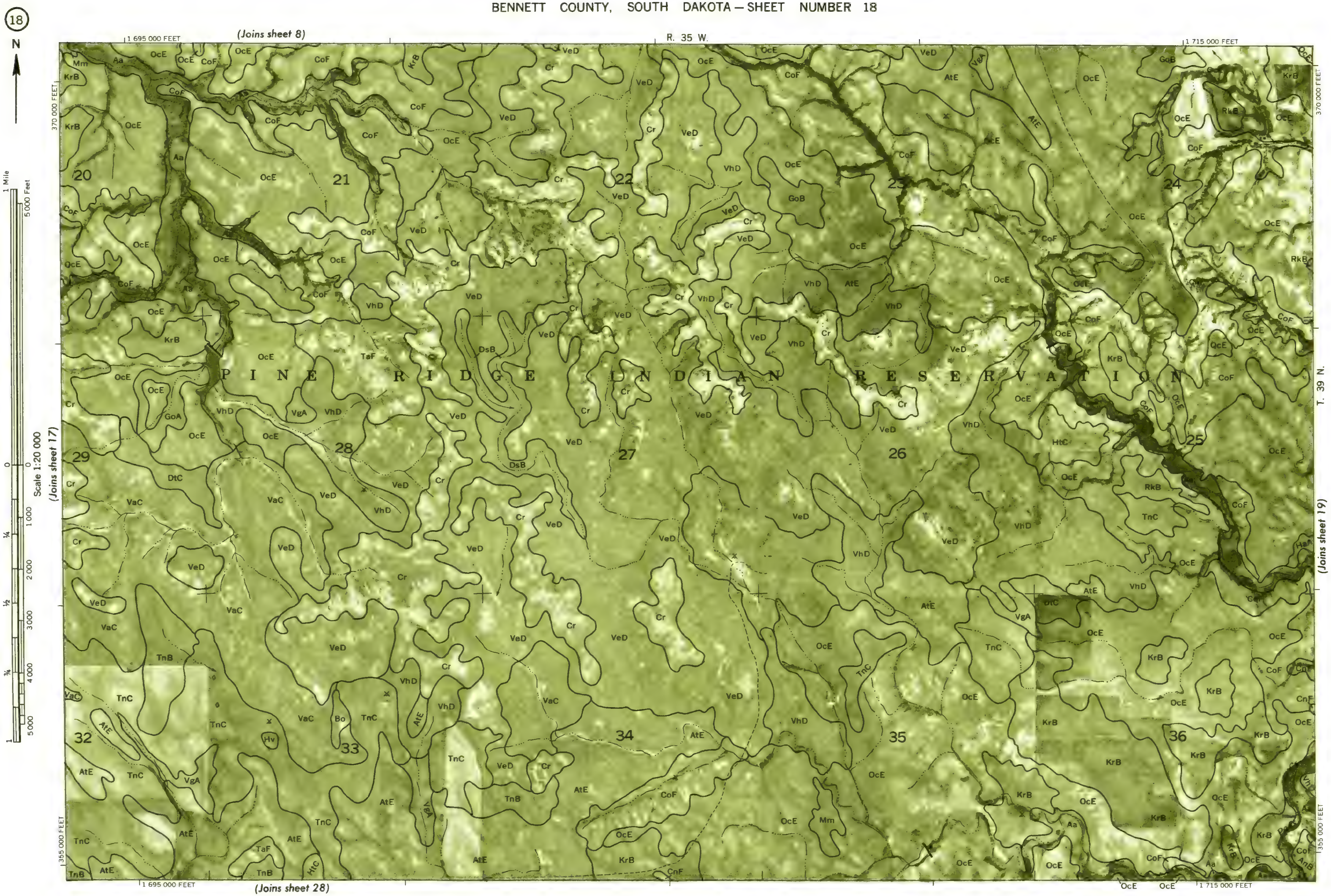
BENNETT COUNTY, SOUTH DAKOTA — SHEET NUMBER 18



Plane coordinate projection. 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

BENNETT COUNTY, SOUTH DAKOTA NO. 18

Land division corners are approximately positioned on this map.

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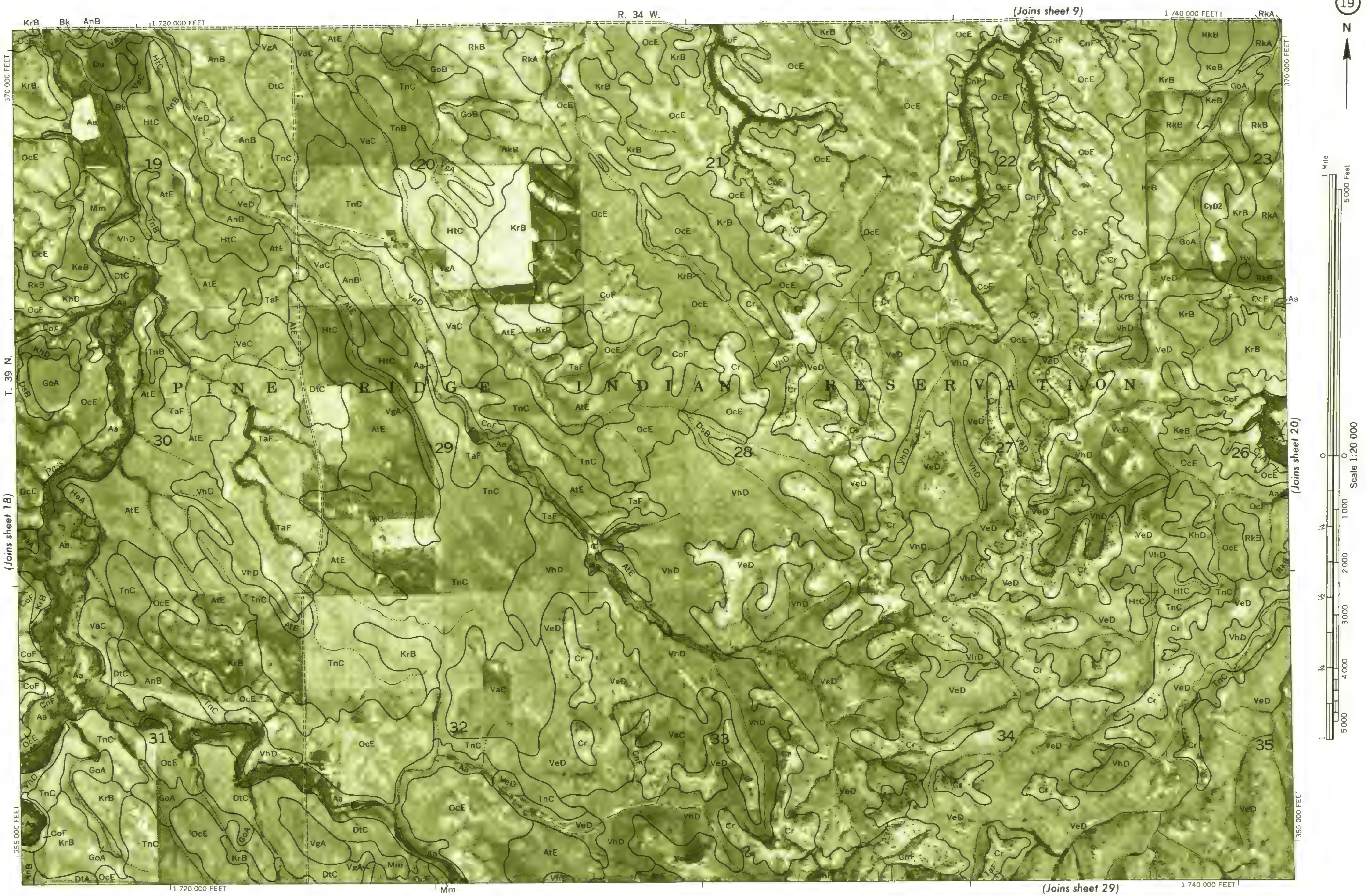
BENNETT COUNTY, SOUTH DAKOTA — SHEET NUMBER 19

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

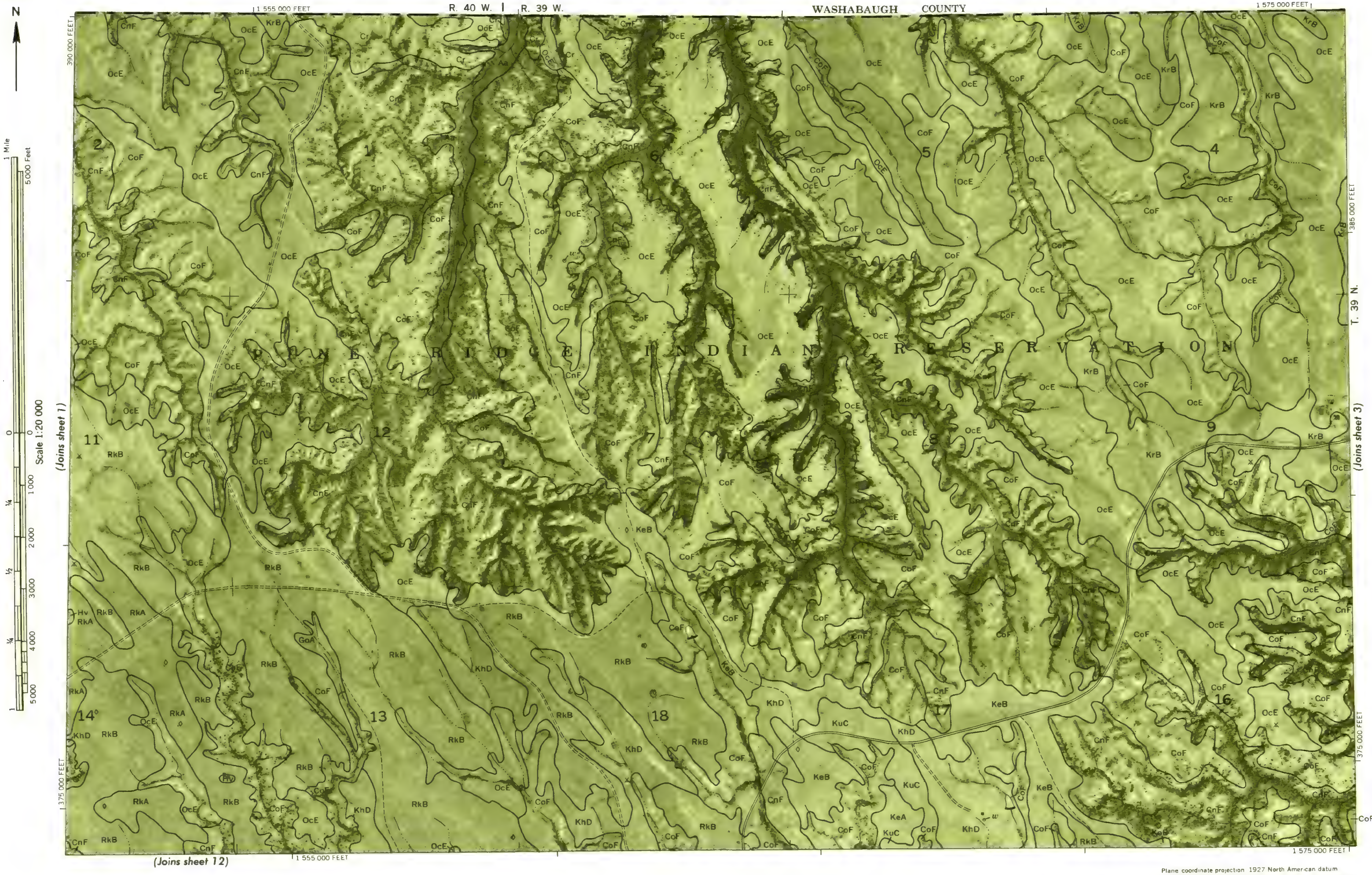
BENNETT COUNTY, SOUTH DAKOTA NO. 19



Plane coordinate projection, 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

(2)

BENNETT COUNTY, SOUTH DAKOTA — SHEET NUMBER 2



Plane coordinate projection 1927 North American datum
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs

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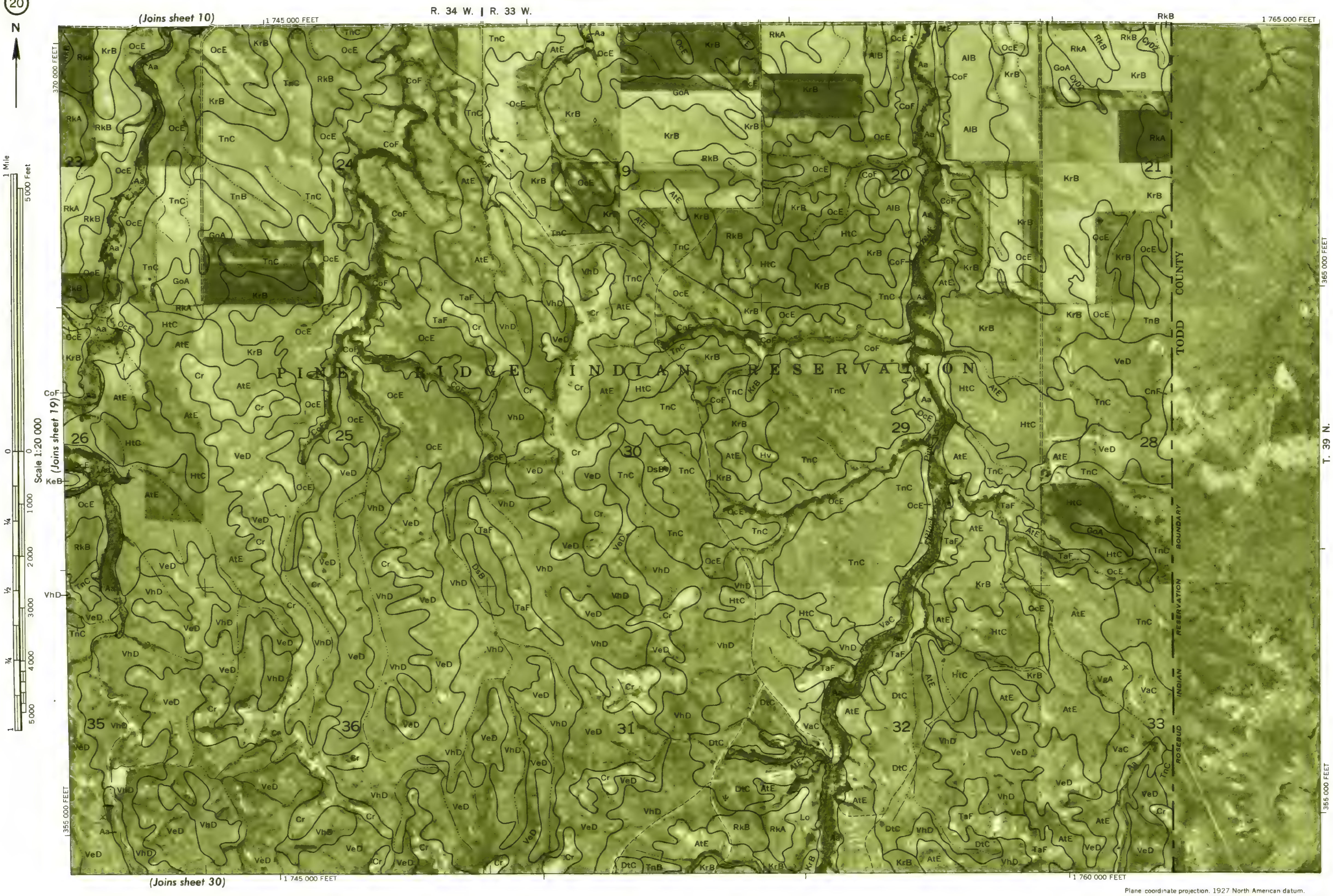
BENNETT COUNTY, SOUTH DAKOTA — SHEET NUMBER 20



Plane coordinate projection. 1927 North American datum. 5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

BENNETT COUNTY, SOUTH DAKOTA NO. 20

Land division corners are approximately positioned on this map.

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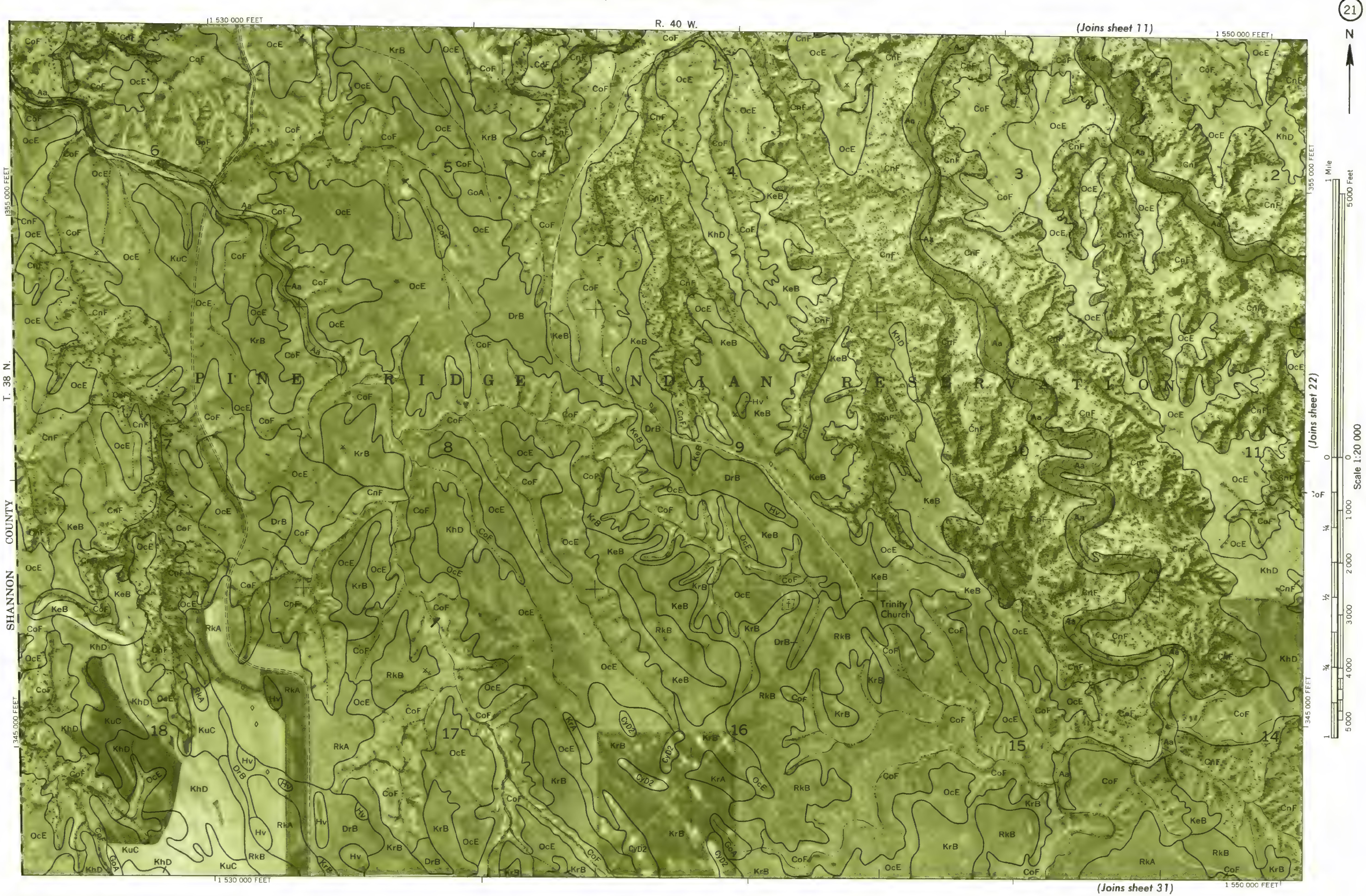

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Land division corners are approximately positioned on this map.

BENNETT COUNTY, SOUTH DAKOTA NO. 21

Plane coordinate projection. 1927 North American datum
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

BENNETT COUNTY, SOUTH DAKOTA — SHEET NUMBER 22

N

Scale 1:20 000

1 Mile — ¾ — ½ — ¼ — 0

5 000 Feet — 4000 — 3000 — 2000 — 1000 — 0

Plane coordinate projection, 1927 North American datum. 5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

BENNETT COUNTY, SOUTH DAKOTA NO. 22

Land division corners are approximately positioned on this map.

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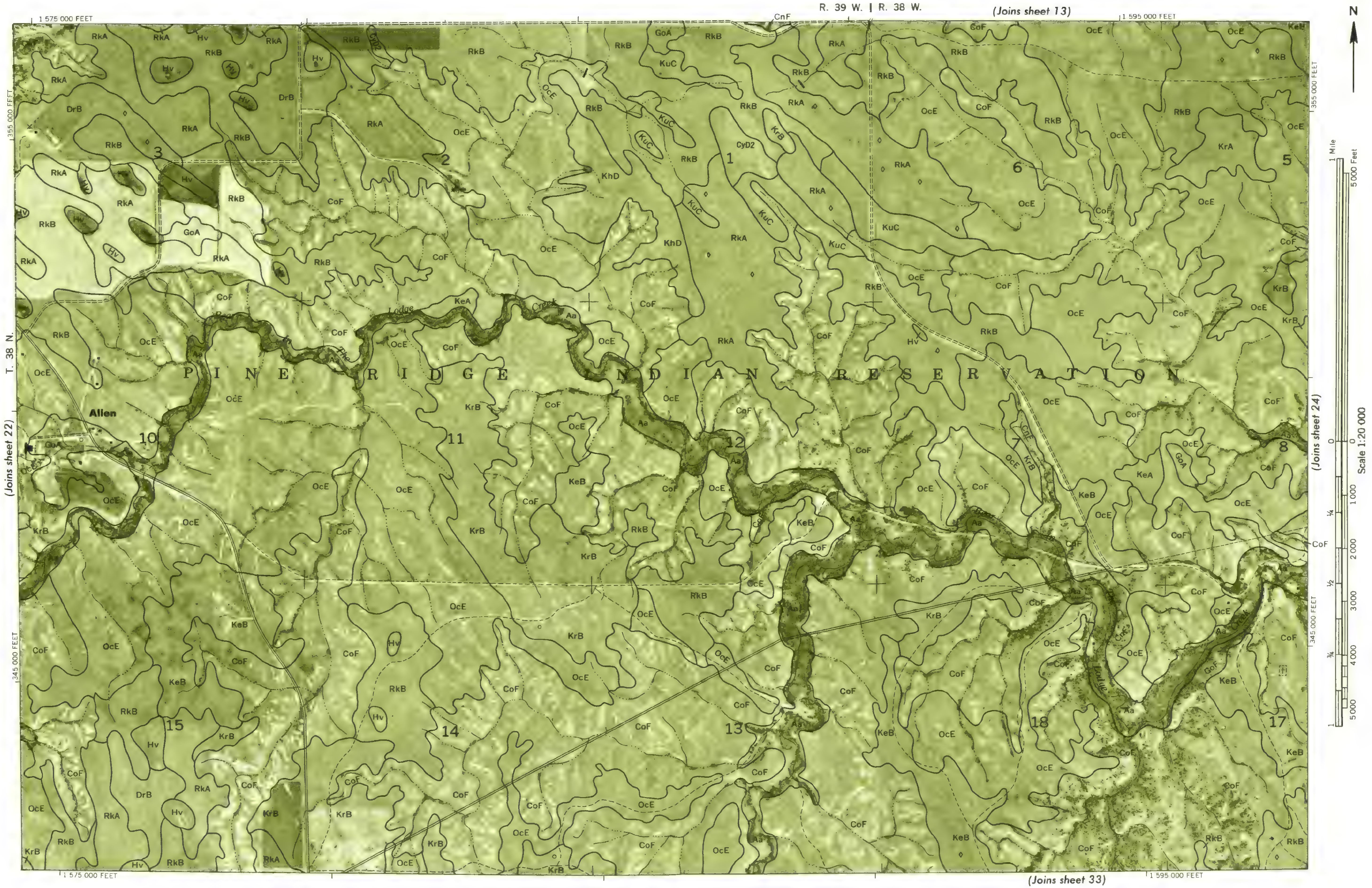
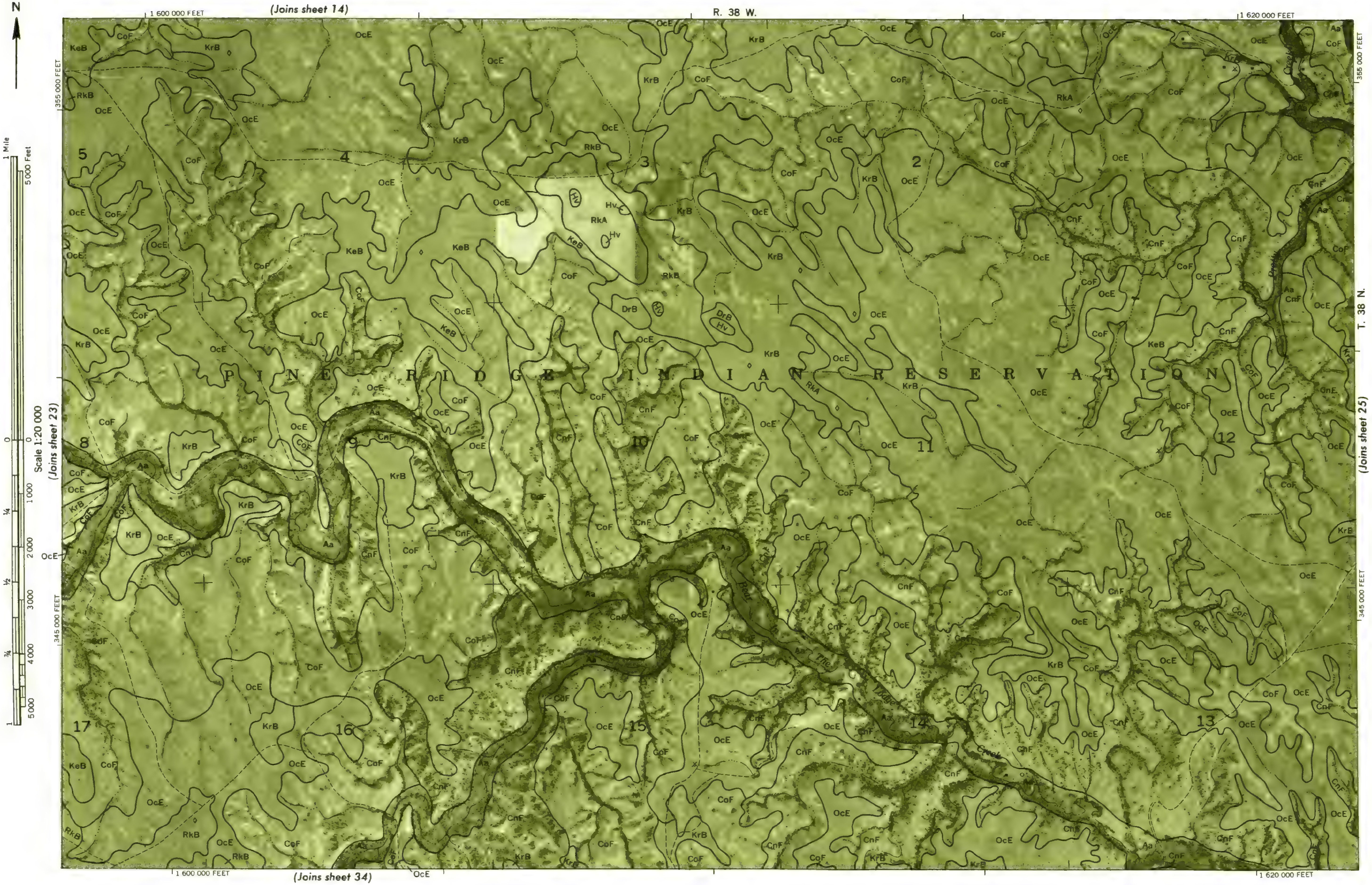
Land division corners are approximately positioned on this map.



Plane coordinate projection 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs



BENNETT COUNTY, SOUTH DAKOTA NO. 24

Land division corners are approximately positioned on this map.

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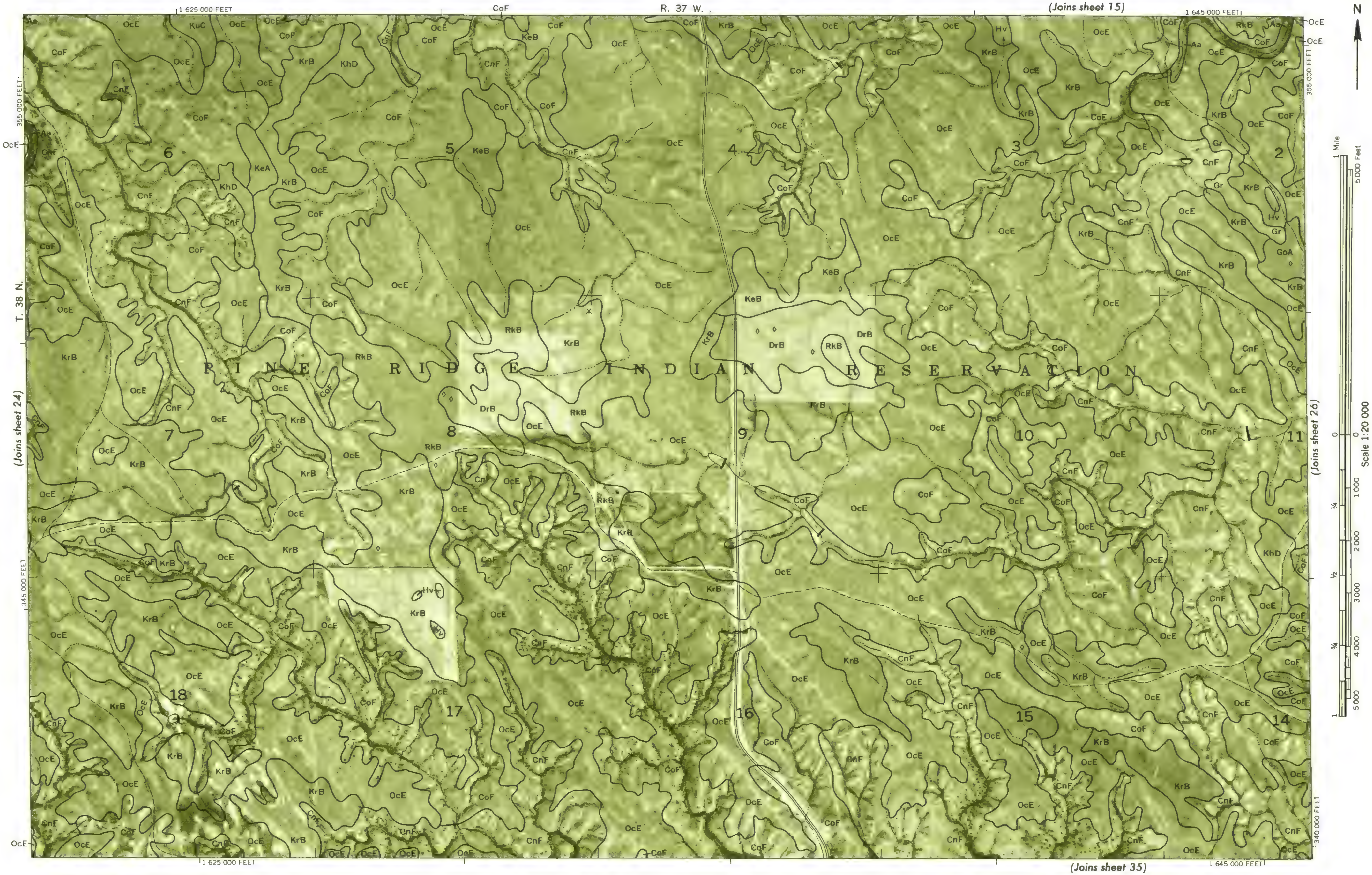
Plane coordinate projection. 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.



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Land division corners are approximately positioned on this map.

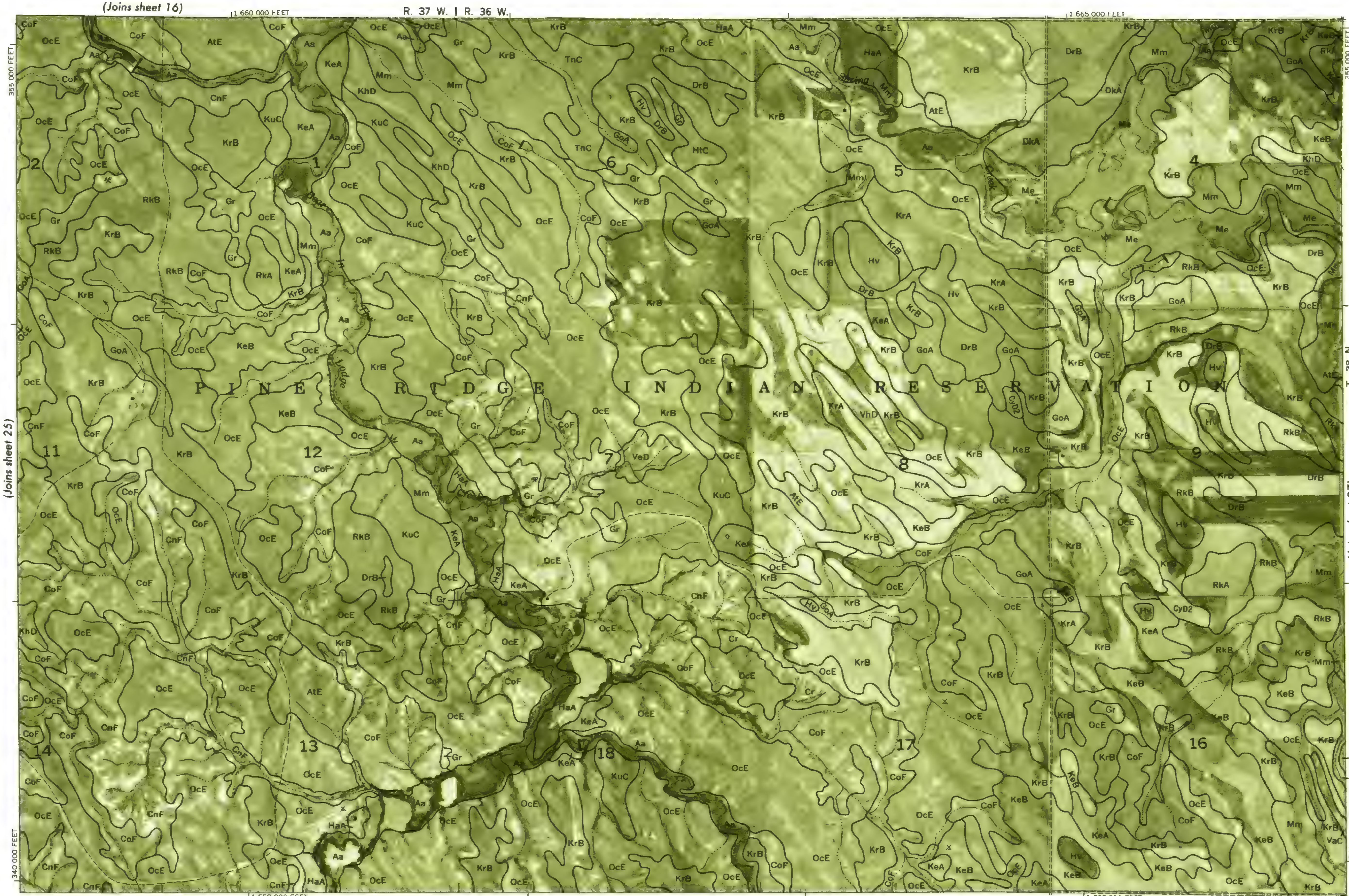
BENNETT COUNTY, SOUTH DAKOTA NO.

Plane coordinate projection, 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

BENNETT COUNTY, SOUTH DAKOTA — SHEET NUMBER 26

N

(Joins sheet 16)



(Joins sheet 25)

(Joins sheet 27)

(Joins sheet 36)

Scale 1:20 000

1 Mile | 5 000 Feet | 0 | 1000 | 2000 | 3000 | 4000 | 5000 | 0 | ¼ | ½ | ¾ | 1

Plane coordinate projection. 1927 North American datum. 5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

BENNETT COUNTY, SOUTH DAKOTA NO. 26

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.

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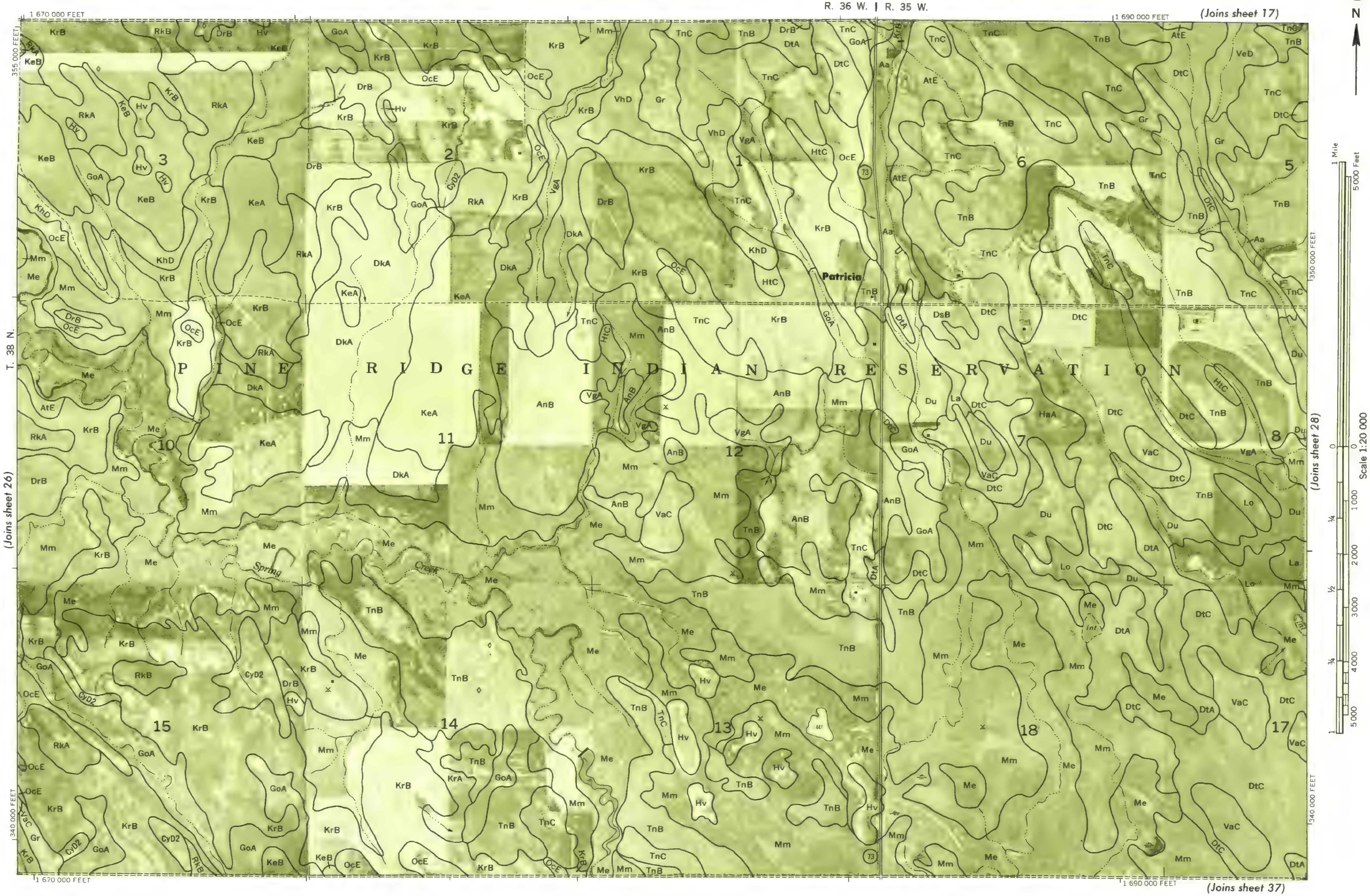
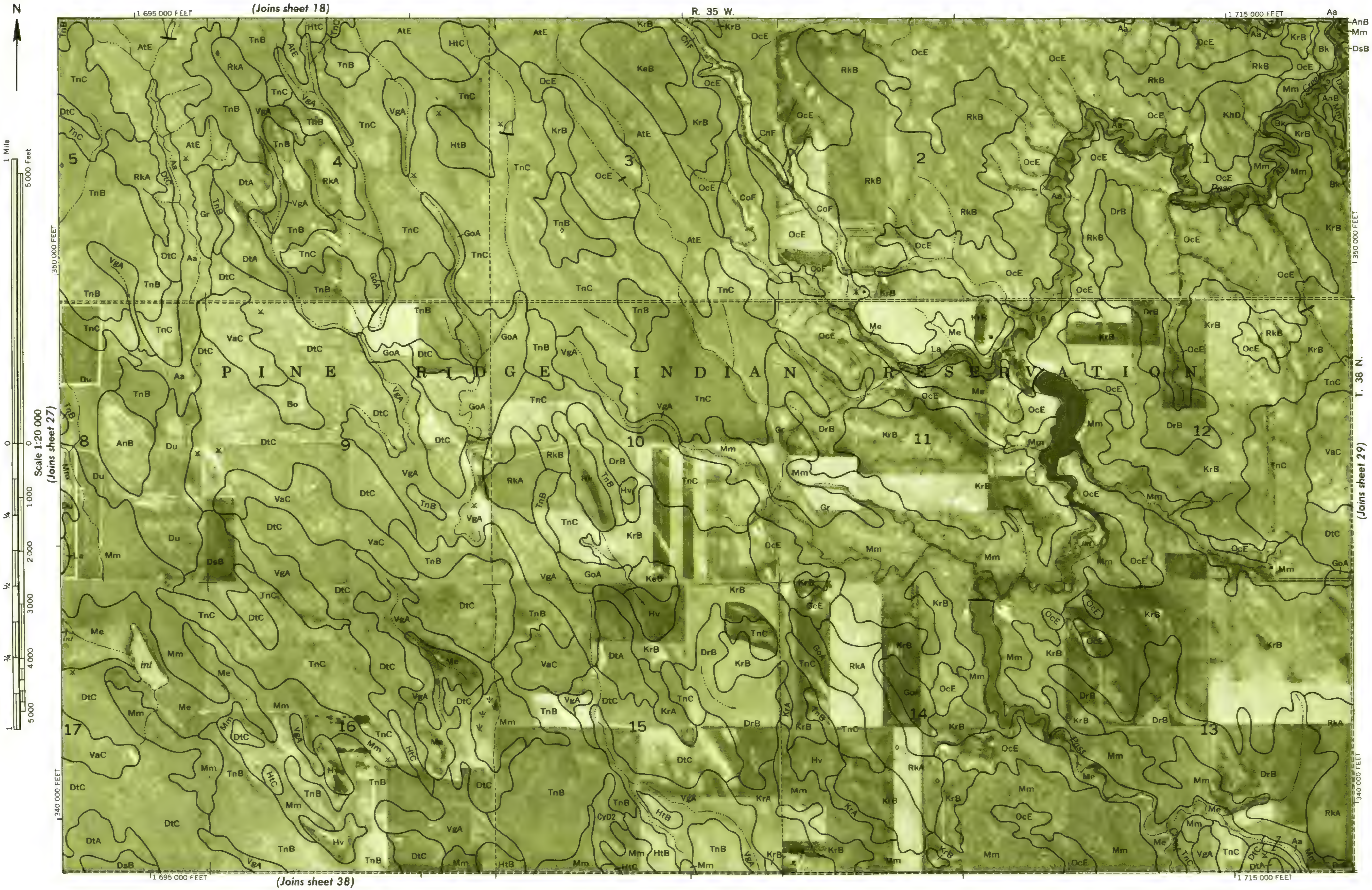
Land division corners are approximately positioned on this map.

BENNETT COUNTY, SOUTH DAKOTA NO. 27



Plane coordinate projection 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.



Plane coordinate projection. 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system,
south zone. Mosaic compiled from 1961 aerial photographs.

BENNETT COUNTY, SOUTH DAKOTA NO. 28

Land division corners are approximately positioned on this map.

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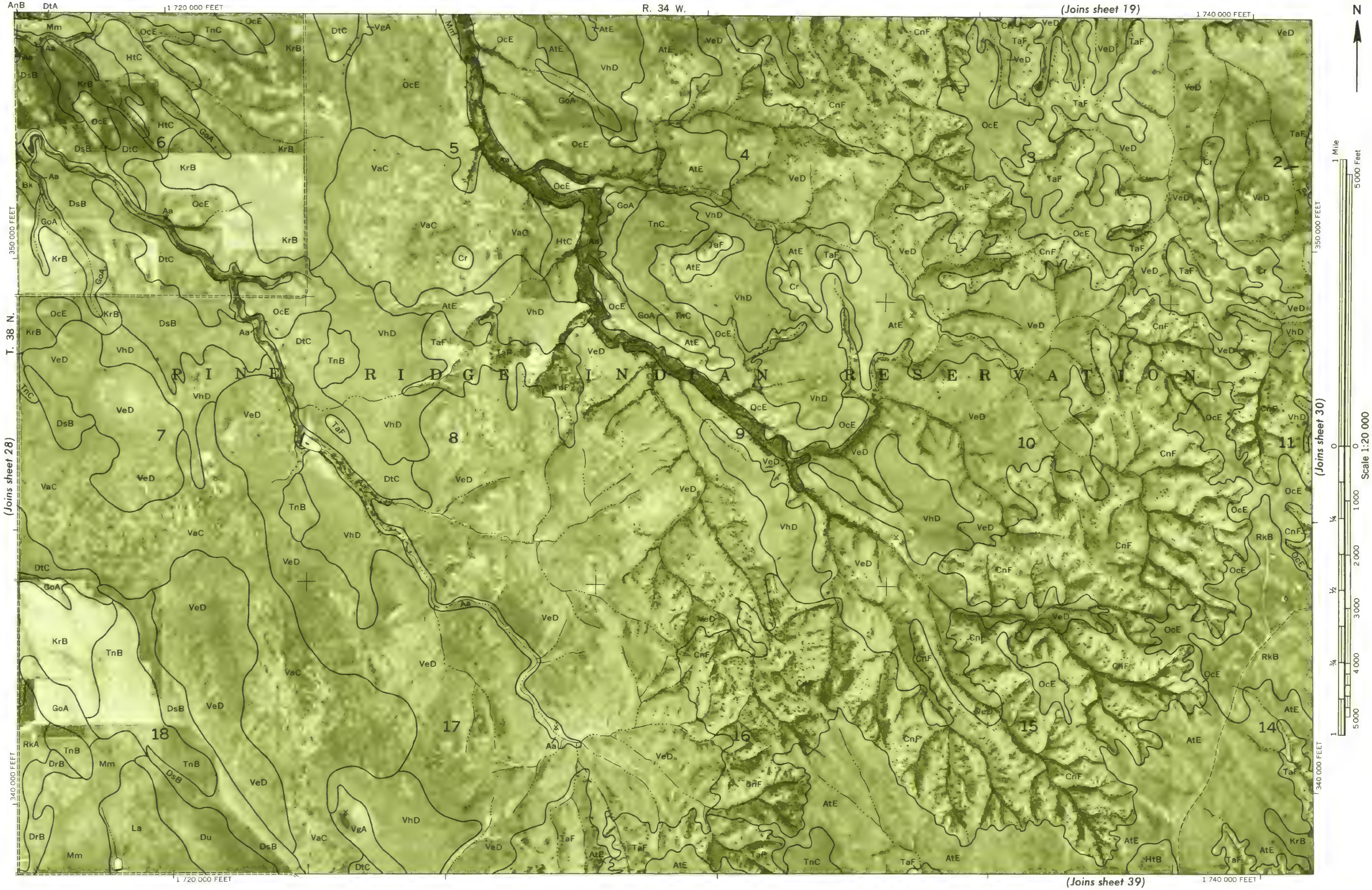
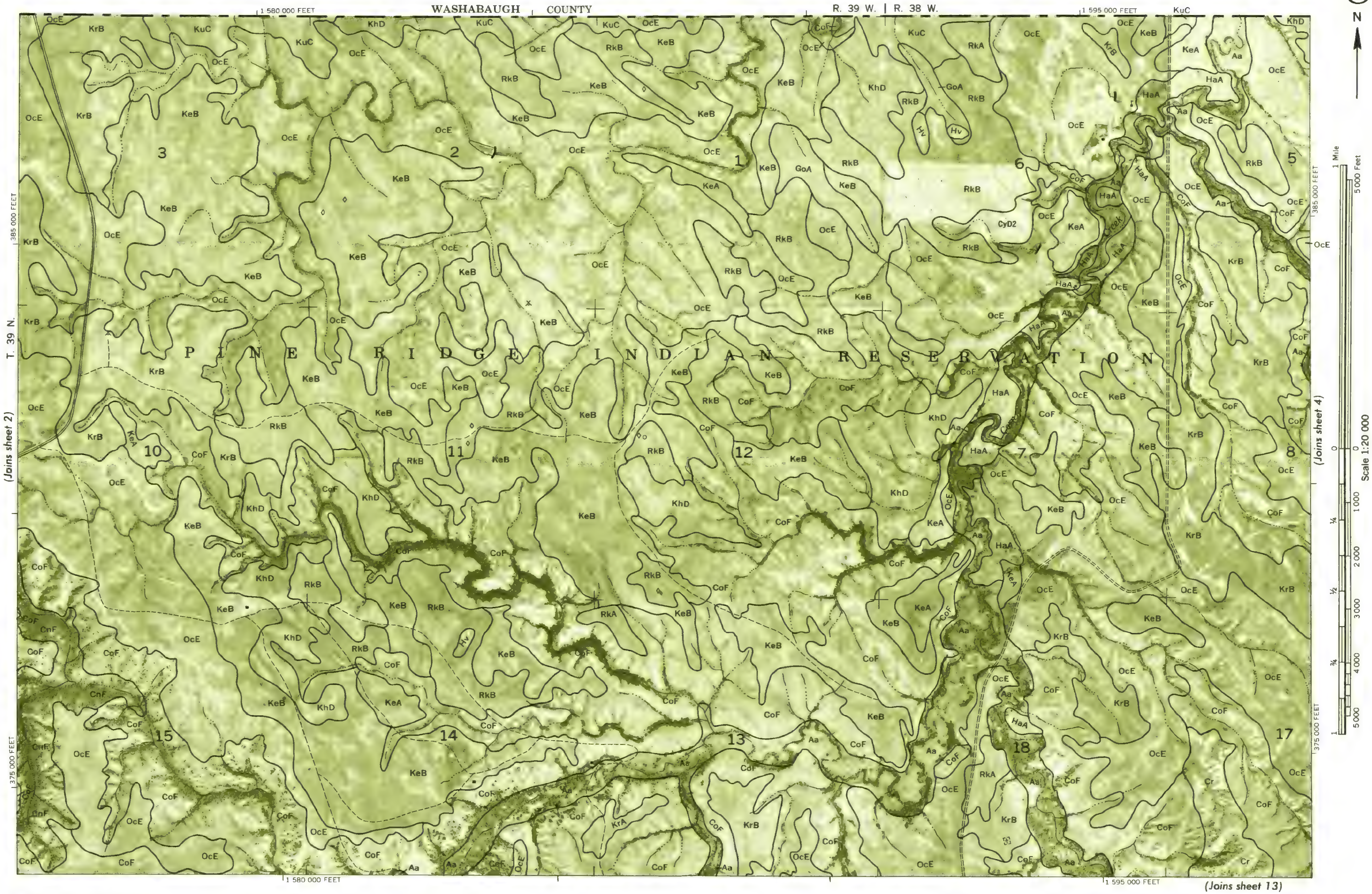
Land division corners are approximately positioned on this map.



Plane coordinate projection 1927 North American datum
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs



Plane coordinate projection 1927 North American datum
5,000-foot grid ticks based on South Dakota coordinate system
south zone. Mosaic compiled from 1961 aerial photographs

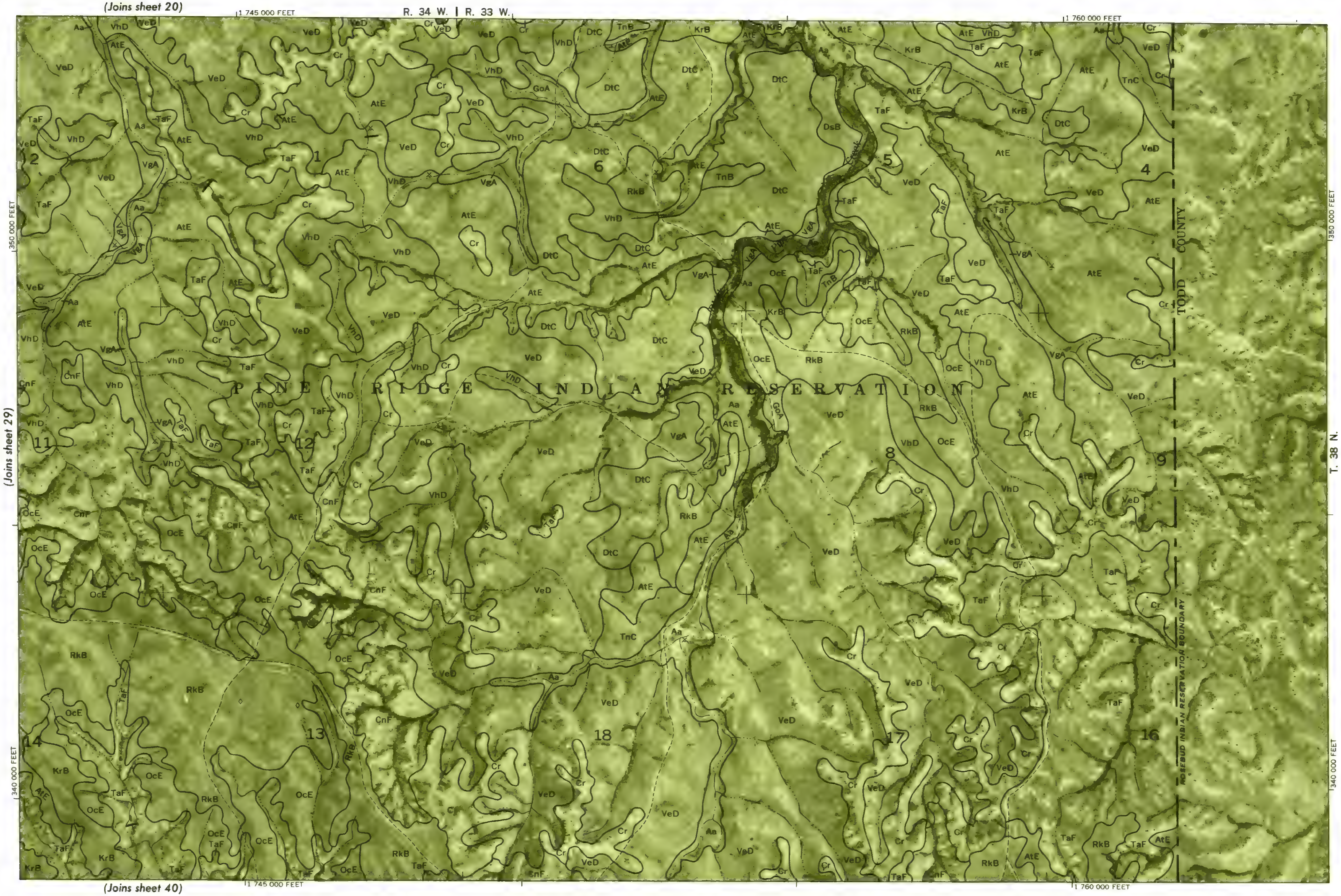
This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station
Land division corners are approximately positioned on this map.

BENNETT COUNTY, SOUTH DAKOTA NO.

BENNETT COUNTY, SOUTH DAKOTA—SHEET NUMBER 30

N

(Joins sheet 20)



(Joins sheet 40)

Scale 1:20 000

1 Mile

5 000 Feet

0 1000 2000 3000 4000 5000

0 ¼ ½ ¾ 1

Plane coordinate projection. 1927 North American datum. 5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

BENNETT COUNTY, SOUTH DAKOTA NO. 30

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.

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Land division corners are approximately positioned on this map.

Plane coordinate projection 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

BENNETT COUNTY, SOUTH DAKOTA — SHEET NUMBER 32

Plane coordinate projection, 1927 North American datum. 5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

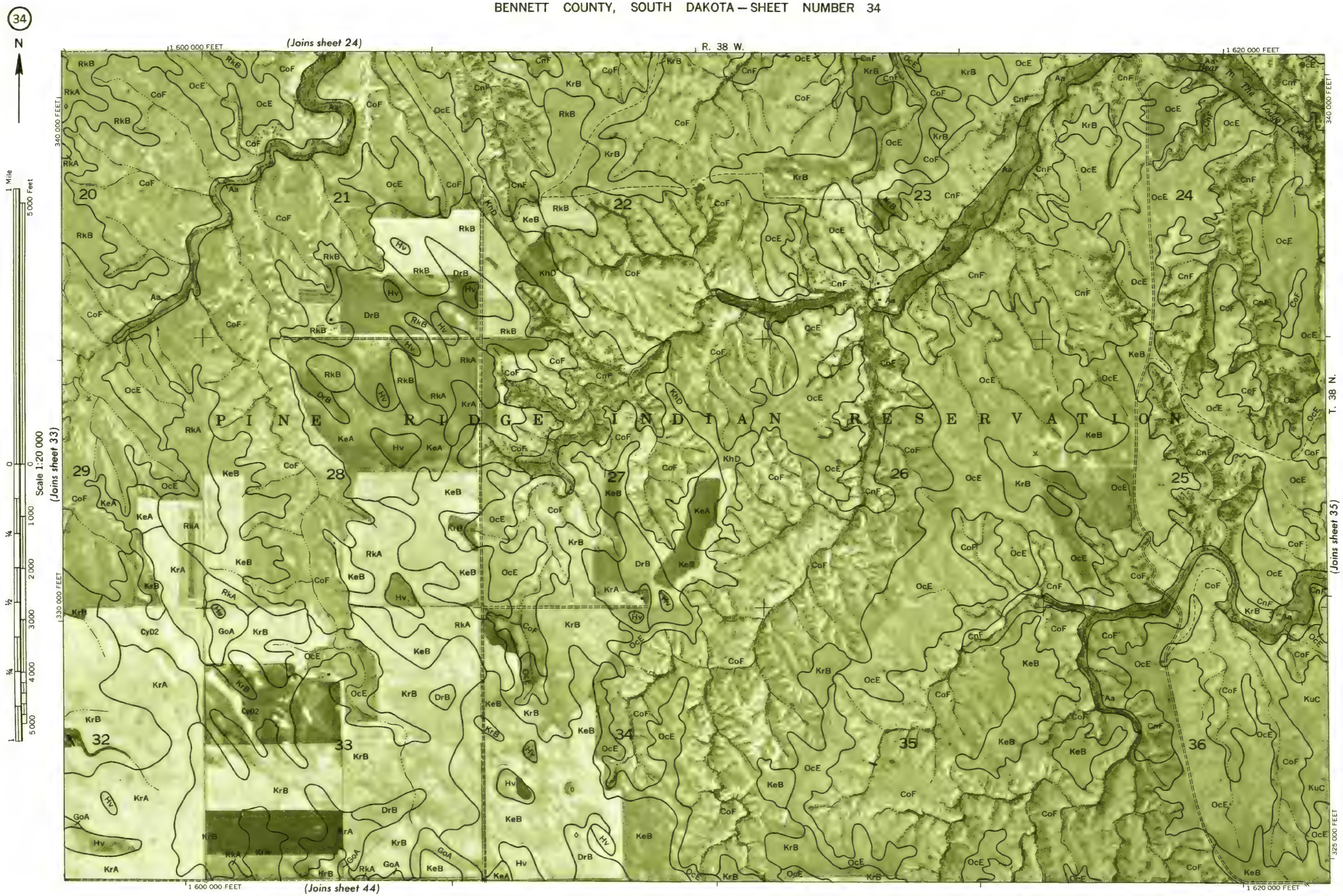
Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

BENNETT COUNTY, SOUTH DAKOTA NO. 33

Plane coordinate projection. 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

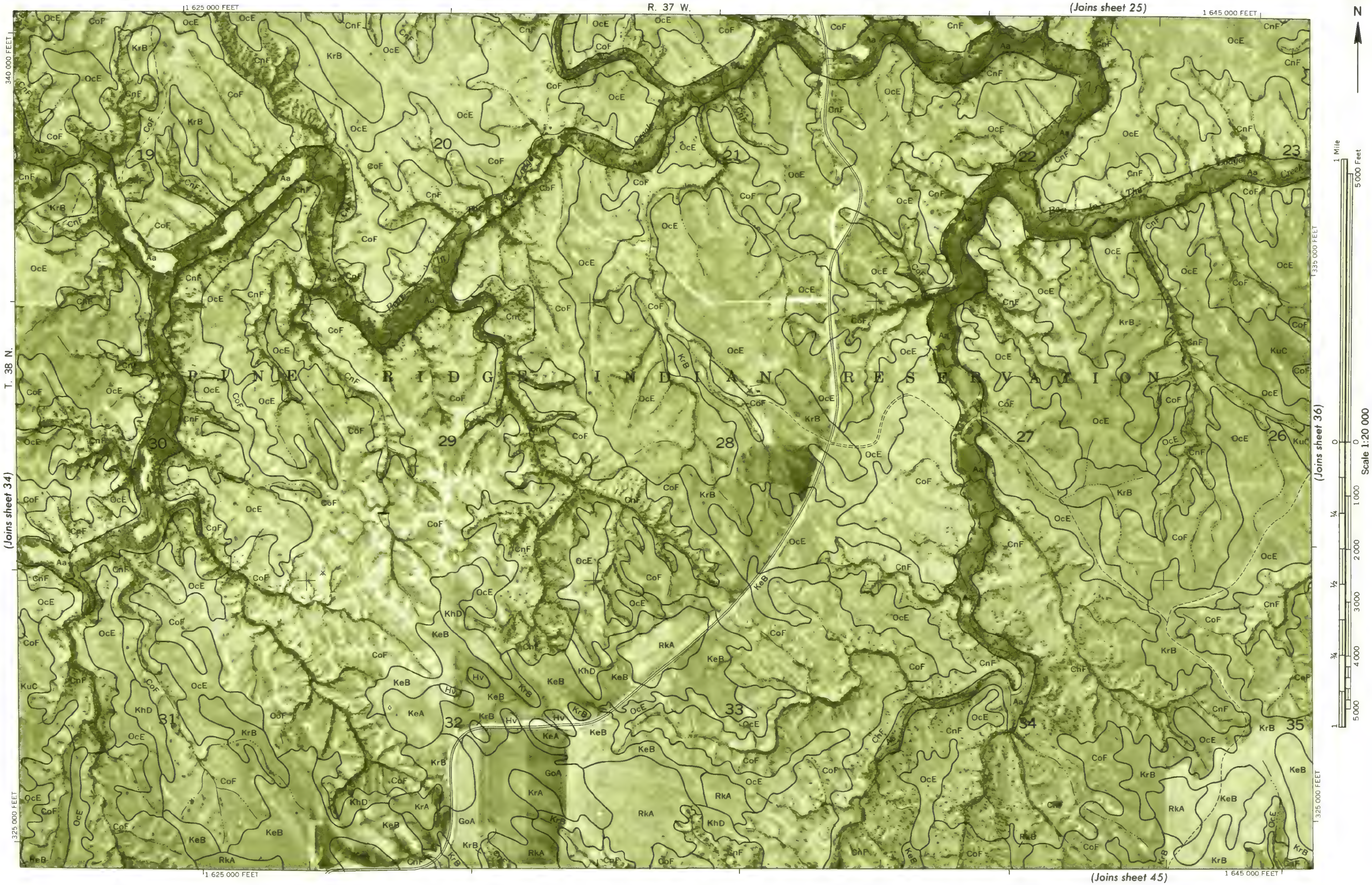


BENNETT COUNTY, SOUTH DAKOTA NO. 34

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station

Plane coordinate projection. 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.



This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs and the South Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

BENNETT COUNTY, SOUTH DAKOTA NO. 35

Plane coordinate projection. 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs

BENNETT COUNTY, SOUTH DAKOTA — SHEET NUMBER 36

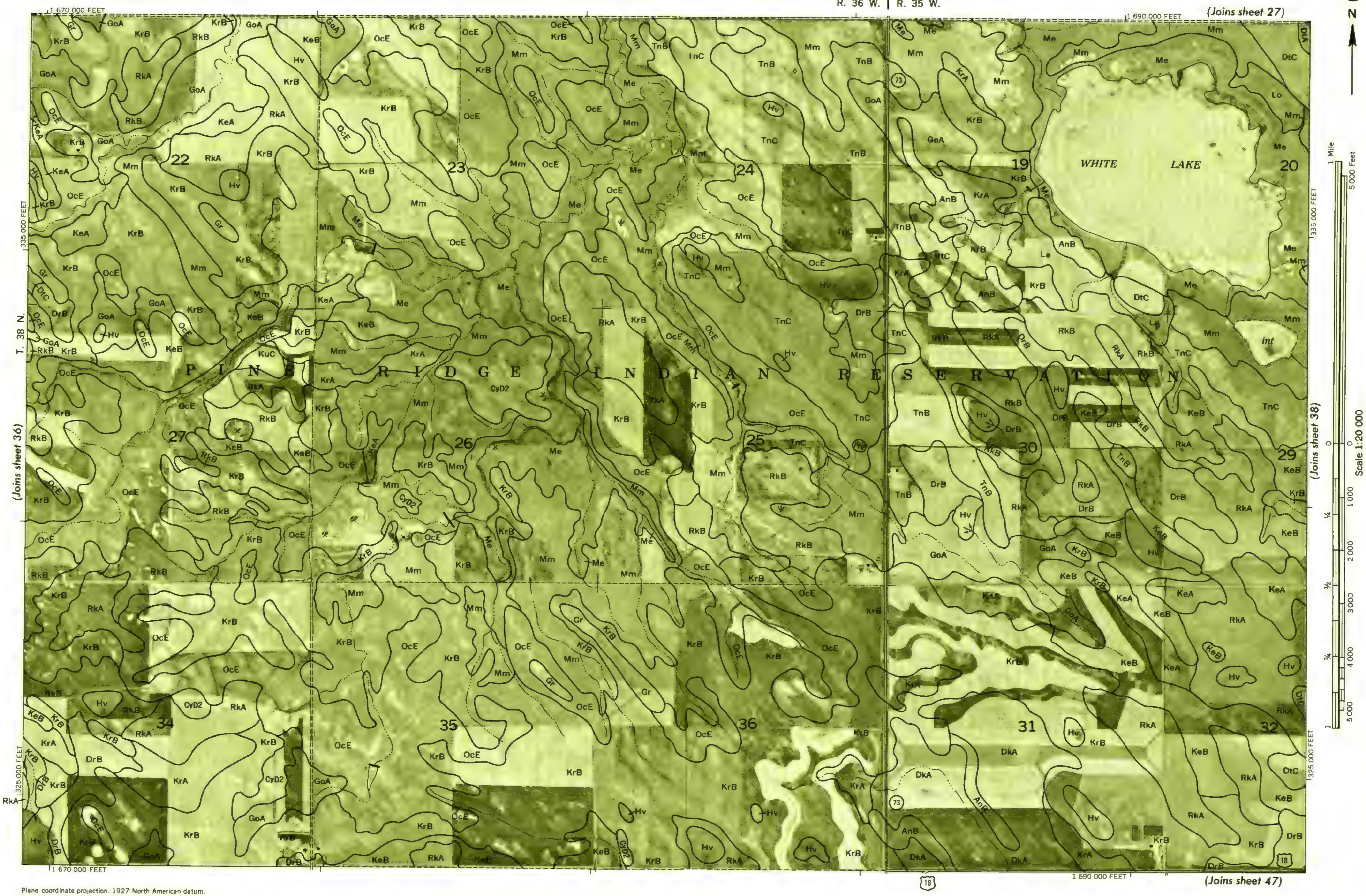
Plane coordinate projection. 1927 North American datum. 5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

BENNETT COUNTY, SOUTH DAKOTA NO. 36

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1959 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.

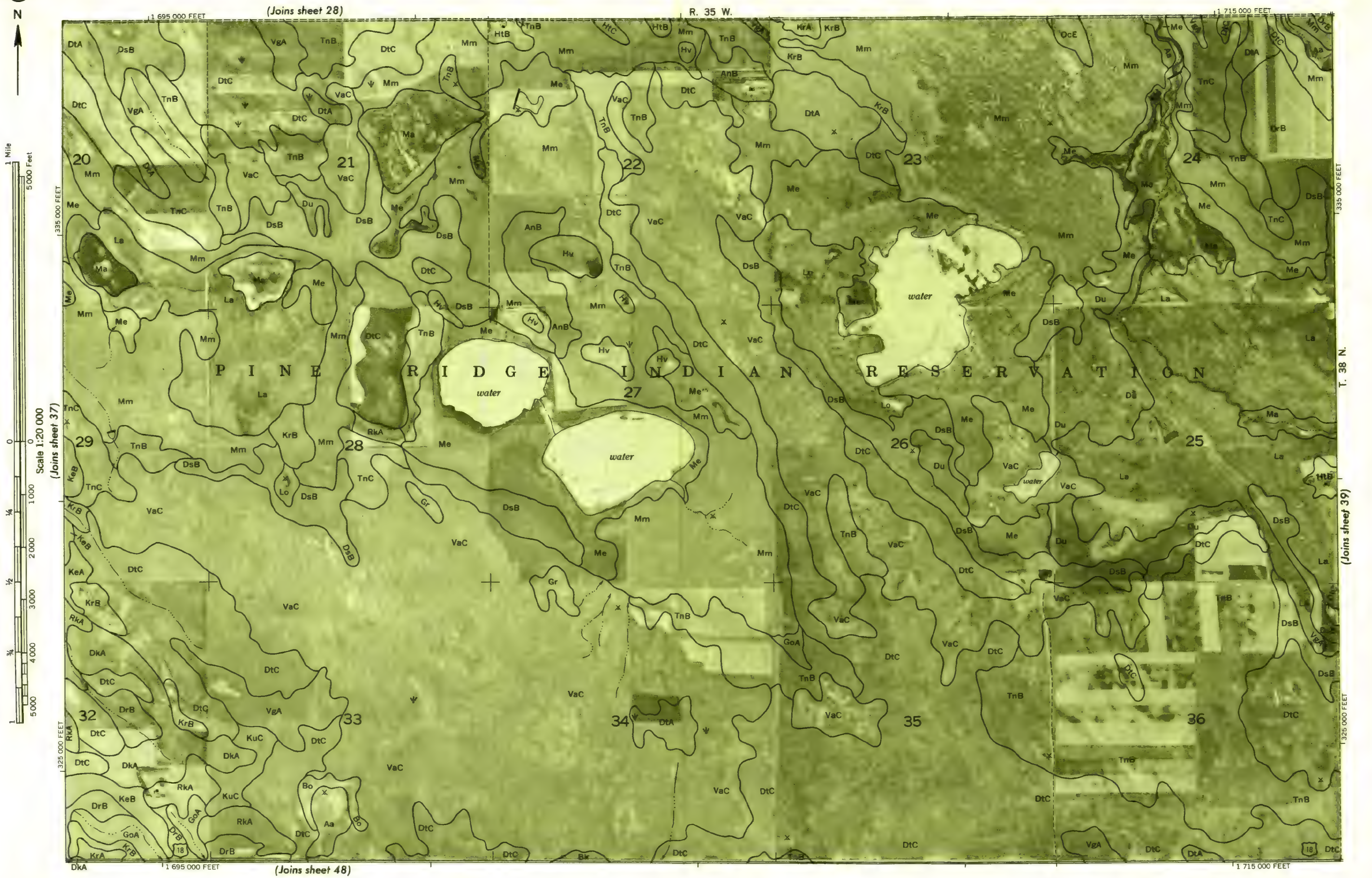
BENNETT COUNTY, SOUTH DAKOTA — SHEET NUMBER 37



This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

BENNETT COUNTY, SOUTH DAKOTA NO. 37

Plane coordinate projection. 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.



BENNETT COUNTY, SOUTH DAKOTA NO. 38

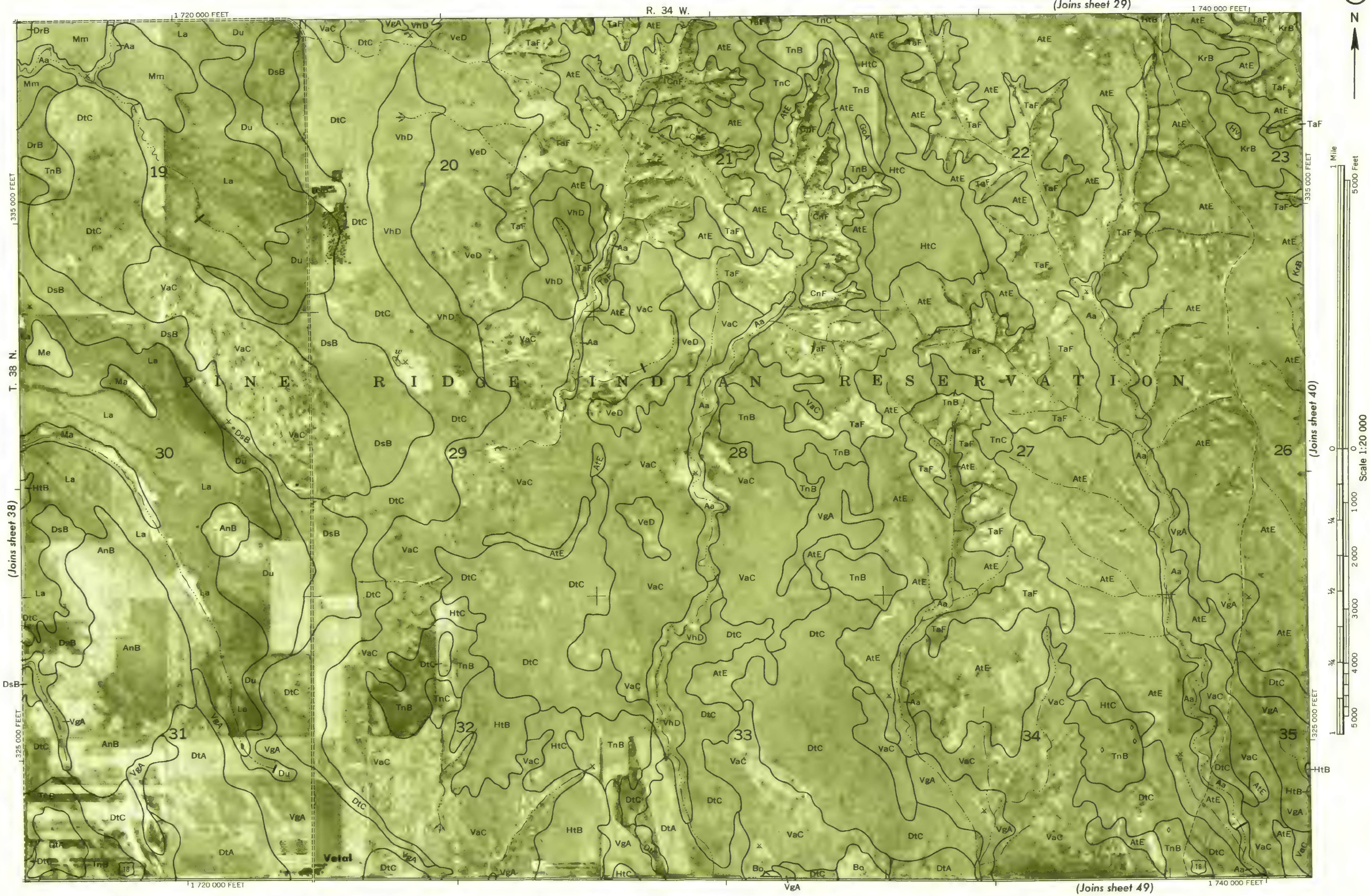
Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.

Plane coordinate projection. 1927 North American datum. 5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

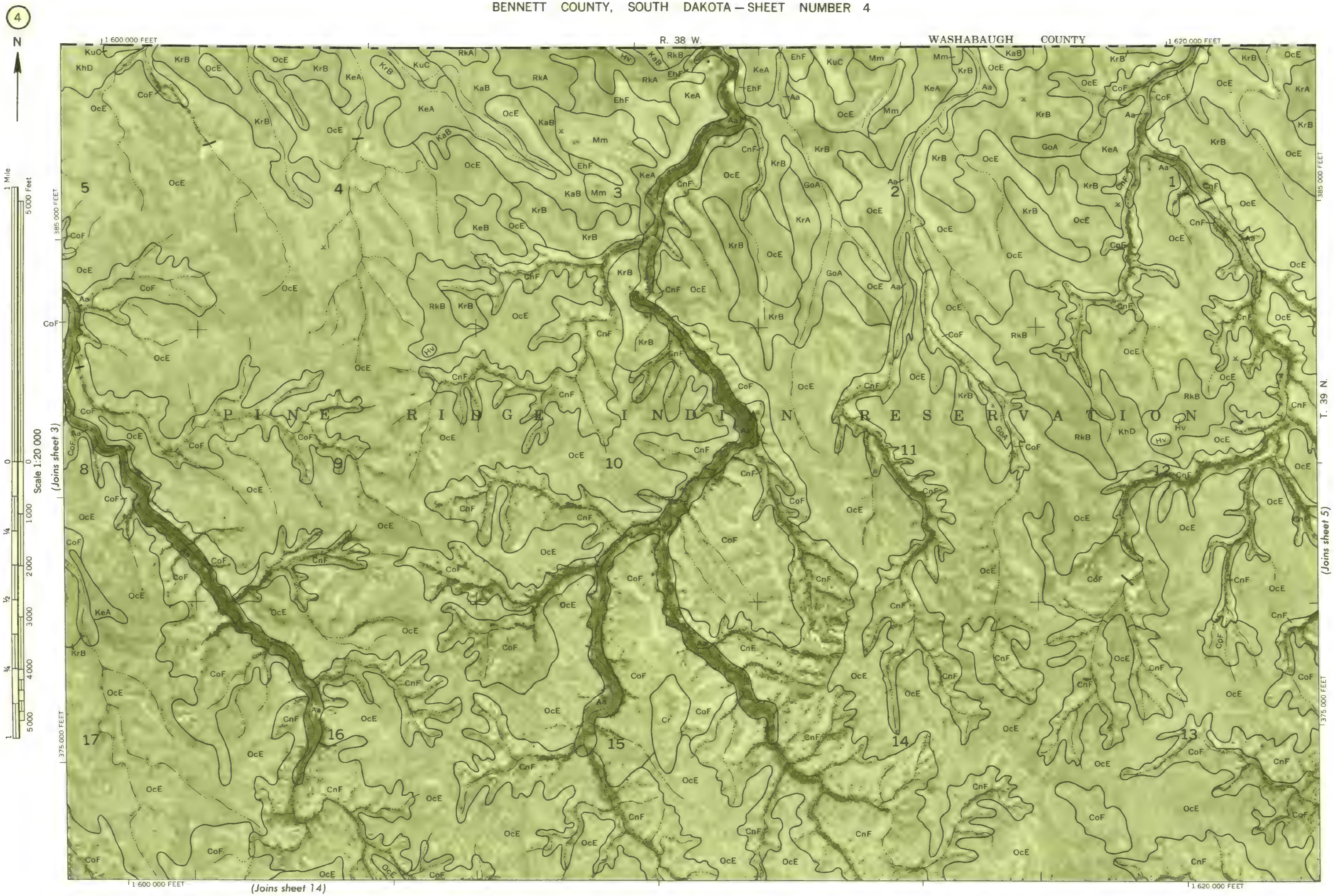
This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

BENNETT COUNTY, SOUTH DAKOTA NO. 39



Plane coordinate projection. 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

BENNETT COUNTY, SOUTH DAKOTA — SHEET NUMBER 4

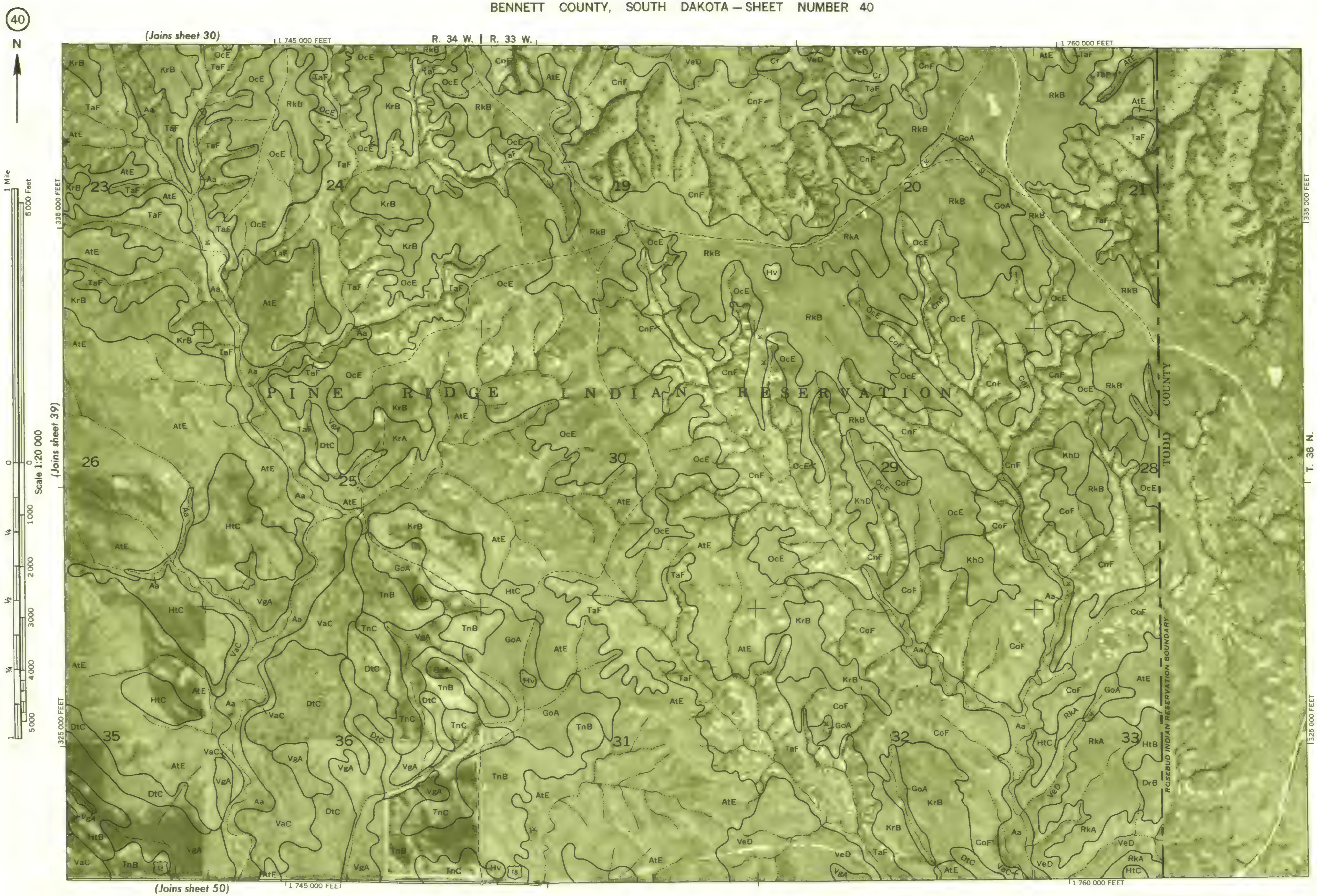


Plane coordinate projection. 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

BENNETT COUNTY, SOUTH DAKOTA NO. 4

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.

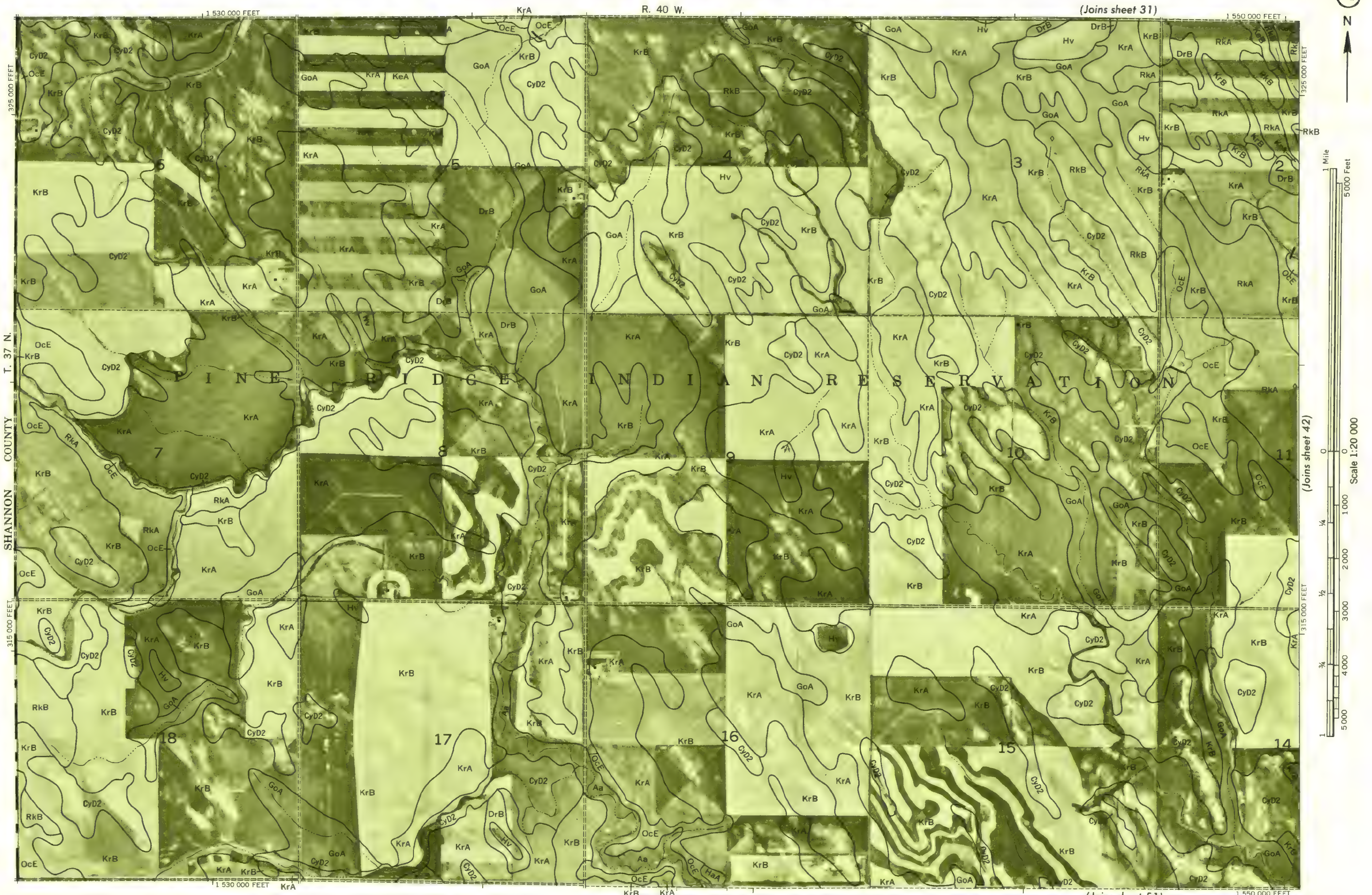


Plane coordinate projection. 1927 North American datum. 5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

BENNETT COUNTY, SOUTH DAKOTA NO. 40

Land division corners are approximately positioned on this map.

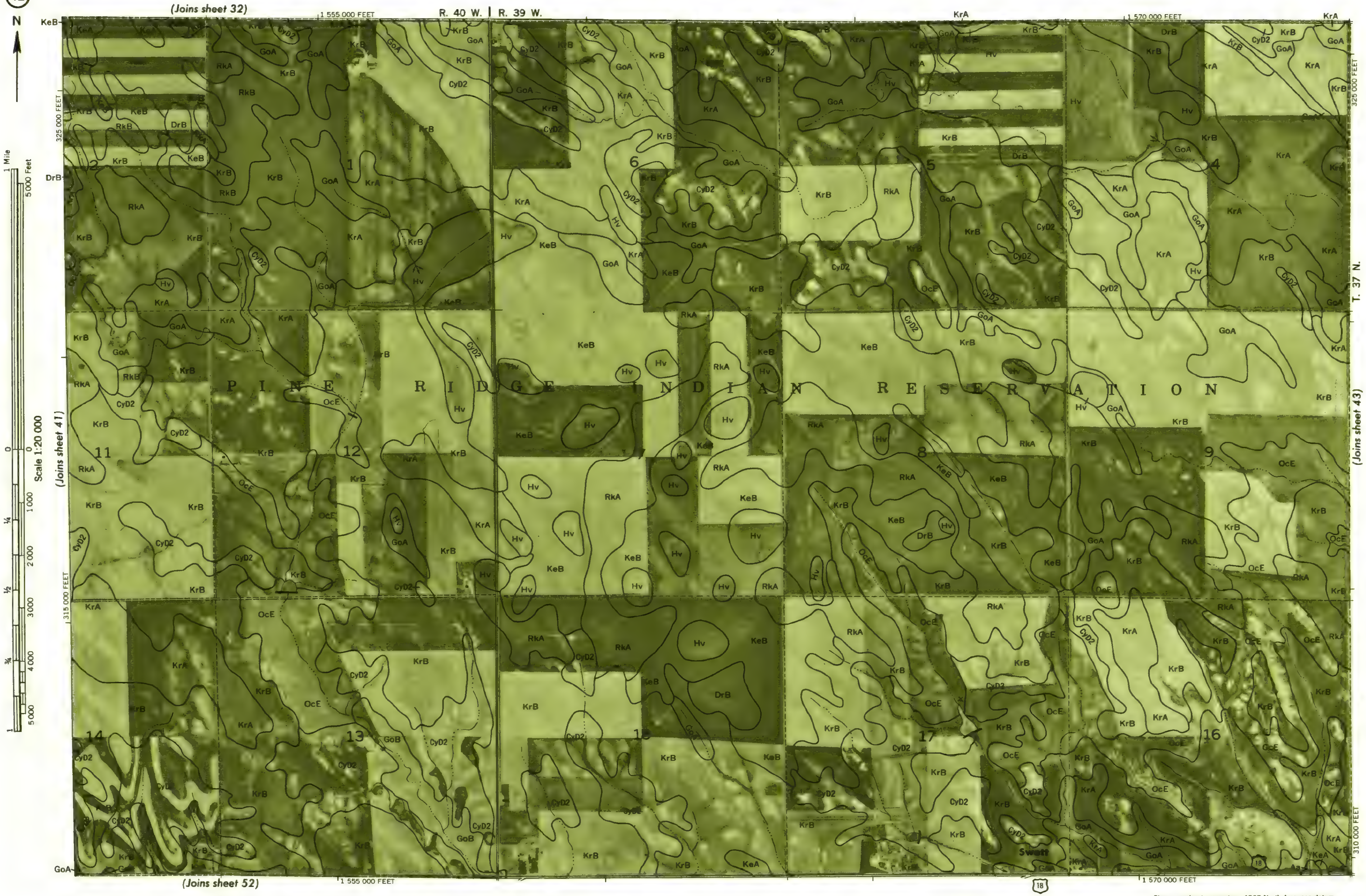
This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs and the South Dakota Agricultural Experiment Station.



Plane coordinate projection. 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

BENNETT COUNTY, SOUTH DAKOTA NO. 41



Plane coordinate projection. 1927 North American datum. 5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

BENNETT COUNTY, SOUTH DAKOTA NO. 42

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

BENNETT COUNTY, SOUTH DAKOTA NO. 43

Plane coordinate projection, 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

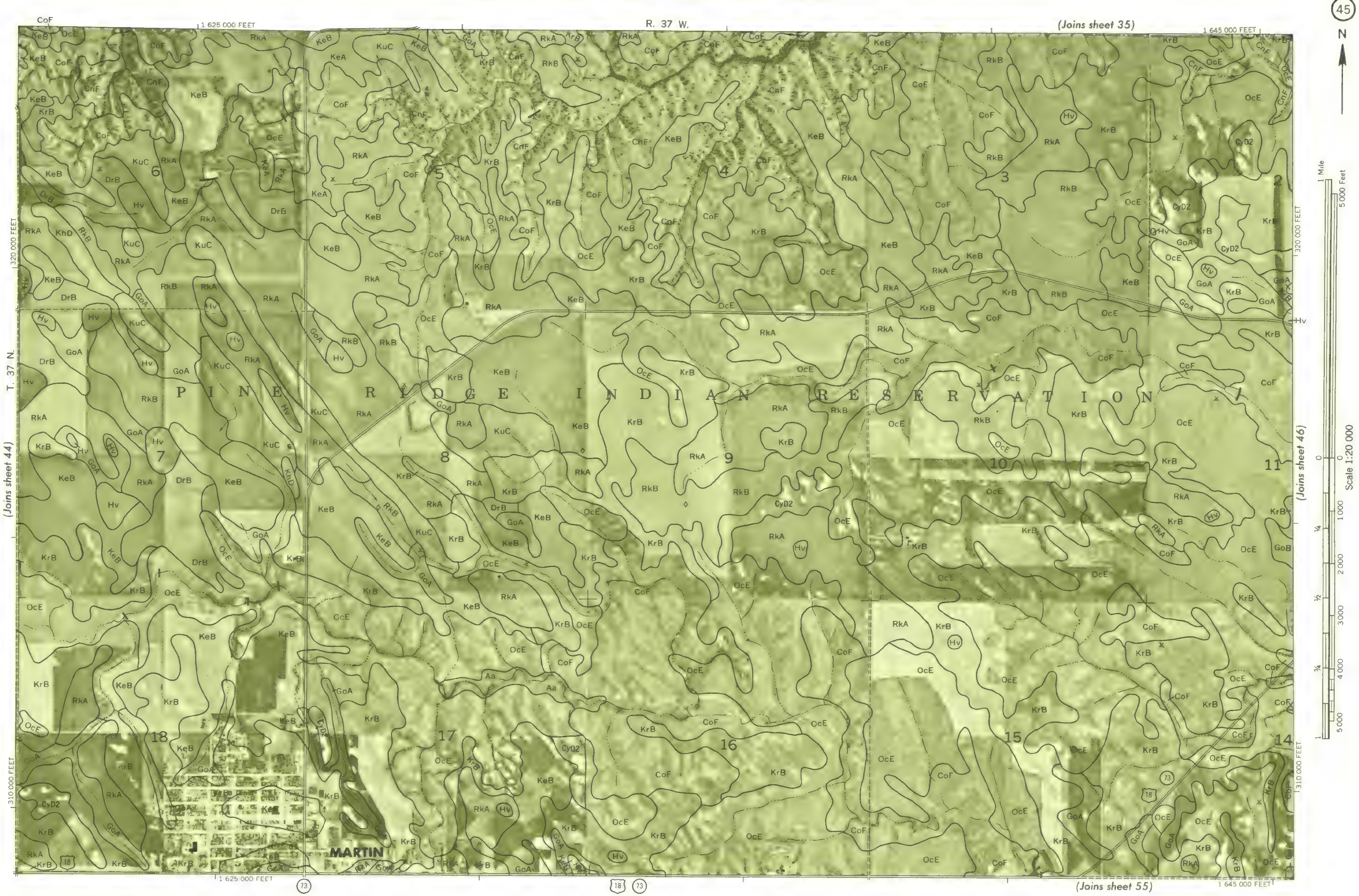
BENNETT COUNTY, SOUTH DAKOTA — SHEET NUMBER 44

Plane coordinate projection. 1927 North American datum. 5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

BENNETT COUNTY, SOUTH DAKOTA NO. 44

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.



This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

Plane coordinate projection 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

BENNETT COUNTY, SOUTH DAKOTA — SHEET NUMBER 46

46

Plane coordinate projection. 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

BENNETT COUNTY, SOUTH DAKOTA NO. 46

Land division corners are approximately positioned on this map.

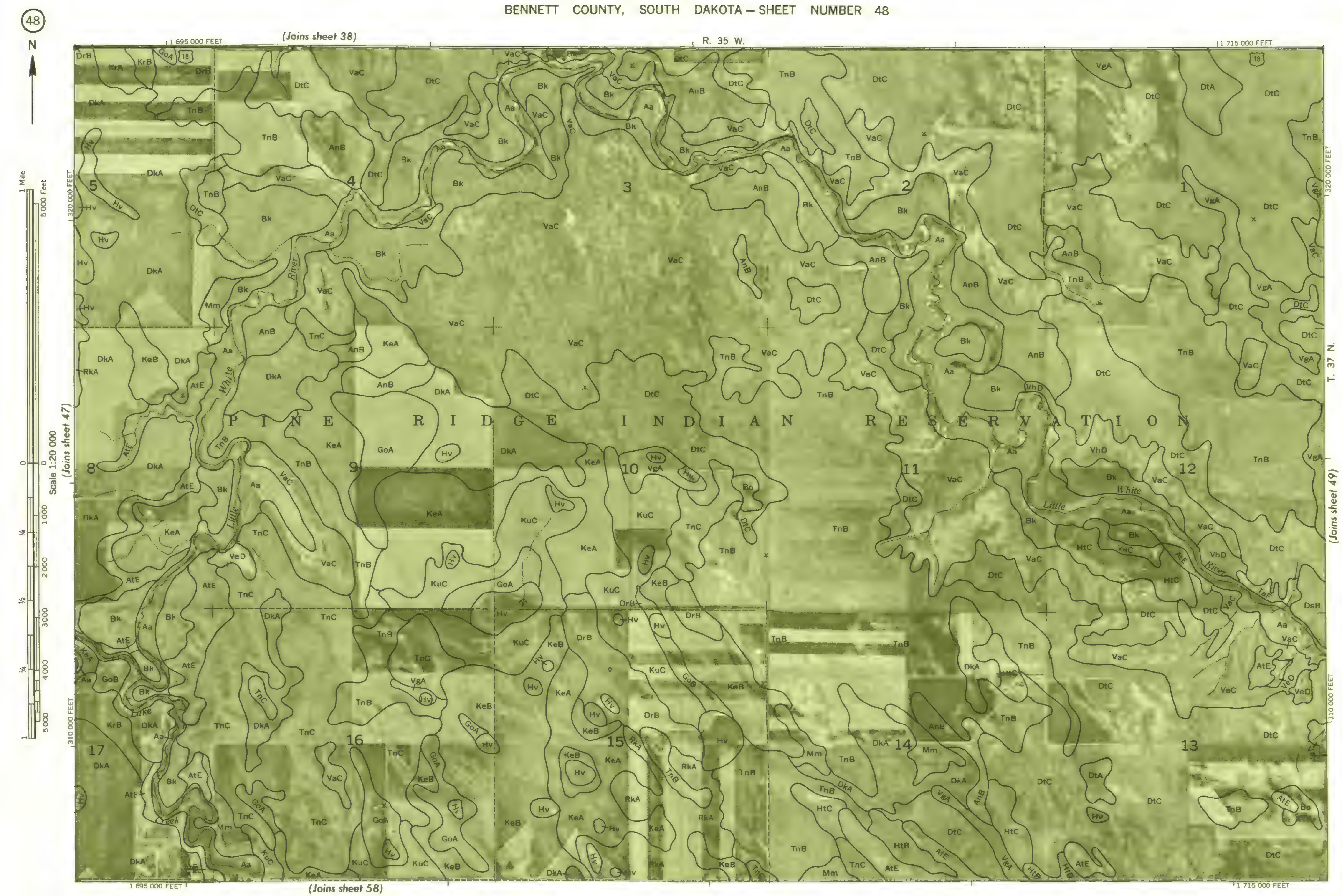
This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.

BENNETT COUNTY, SOUTH DAKOTA — SHEET NUMBER 47

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

BENNETT COUNTY, SOUTH DAKOTA NO. 47

Plane coordinate projection. 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

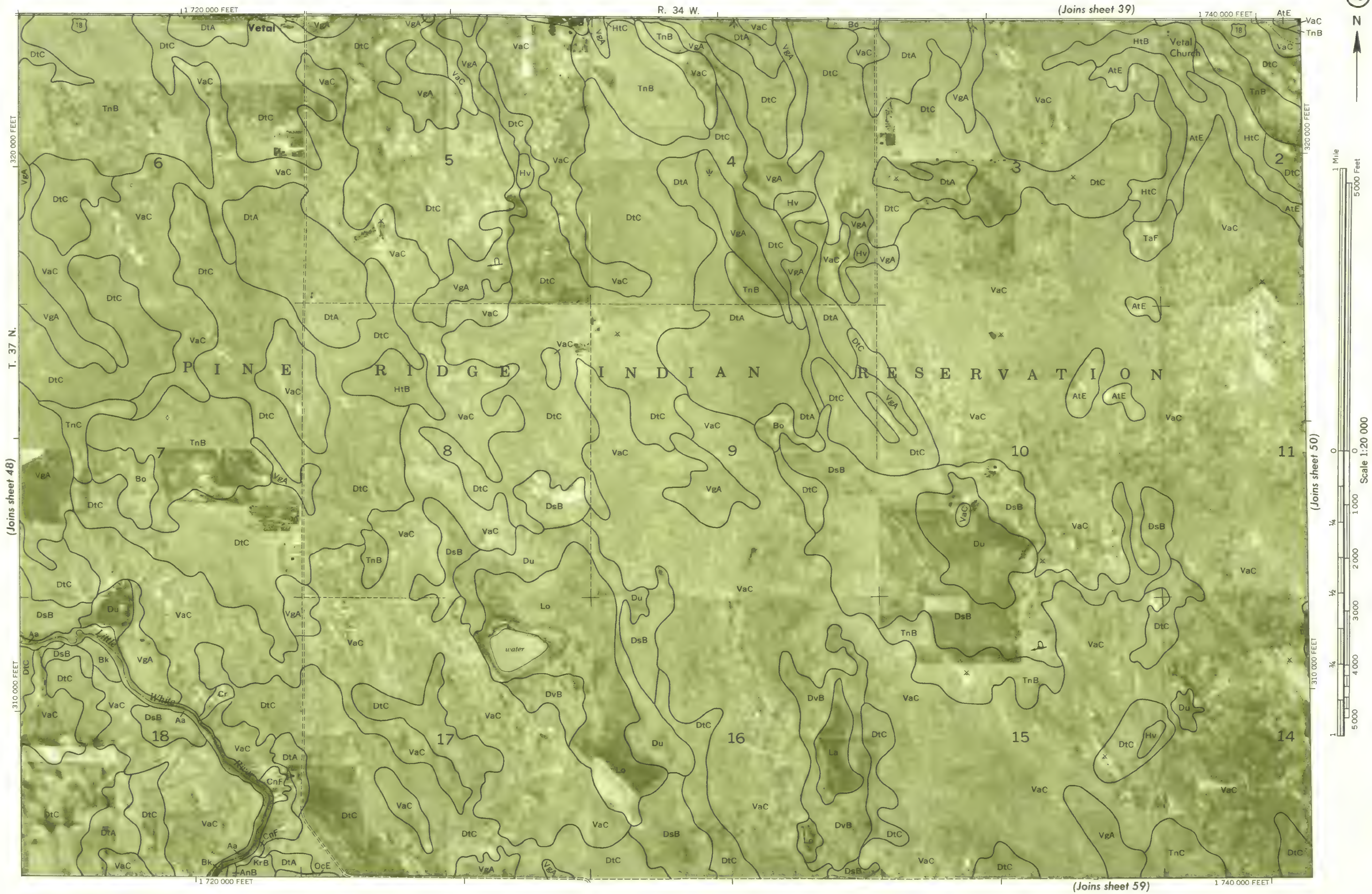


Plane coordinate projection. 1927 North American datum. 5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

BENNETT COUNTY, SOUTH DAKOTA NO. 48

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.

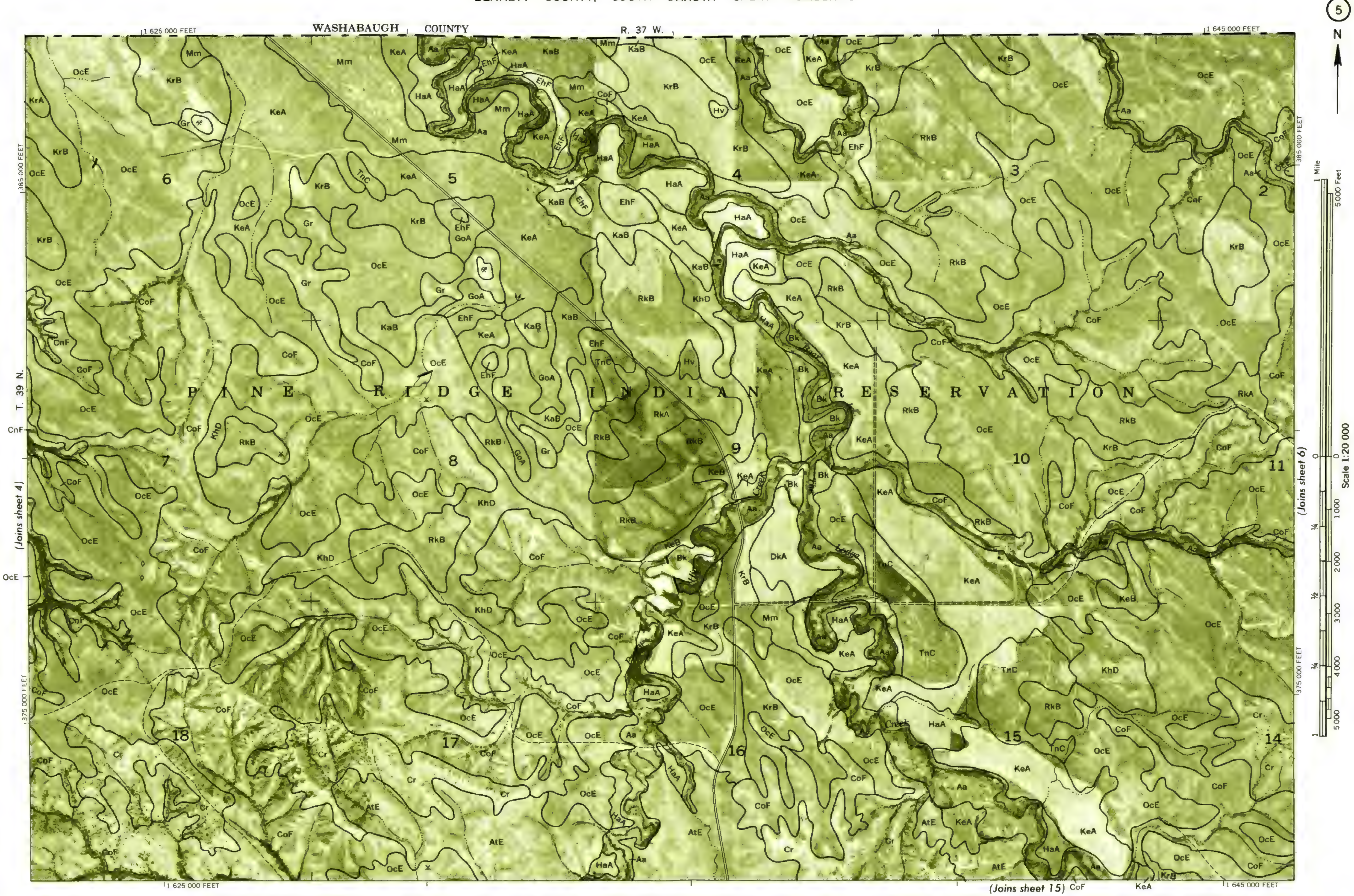


This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

BENNETT COUNTY, SOUTH DAKOTA NO. 49

Plane coordinate projection. 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

BENNETT COUNTY, SOUTH DAKOTA — SHEET NUMBER 5



Plane coordinate projection. 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

BENNETT COUNTY, SOUTH DAKOTA NO. 5

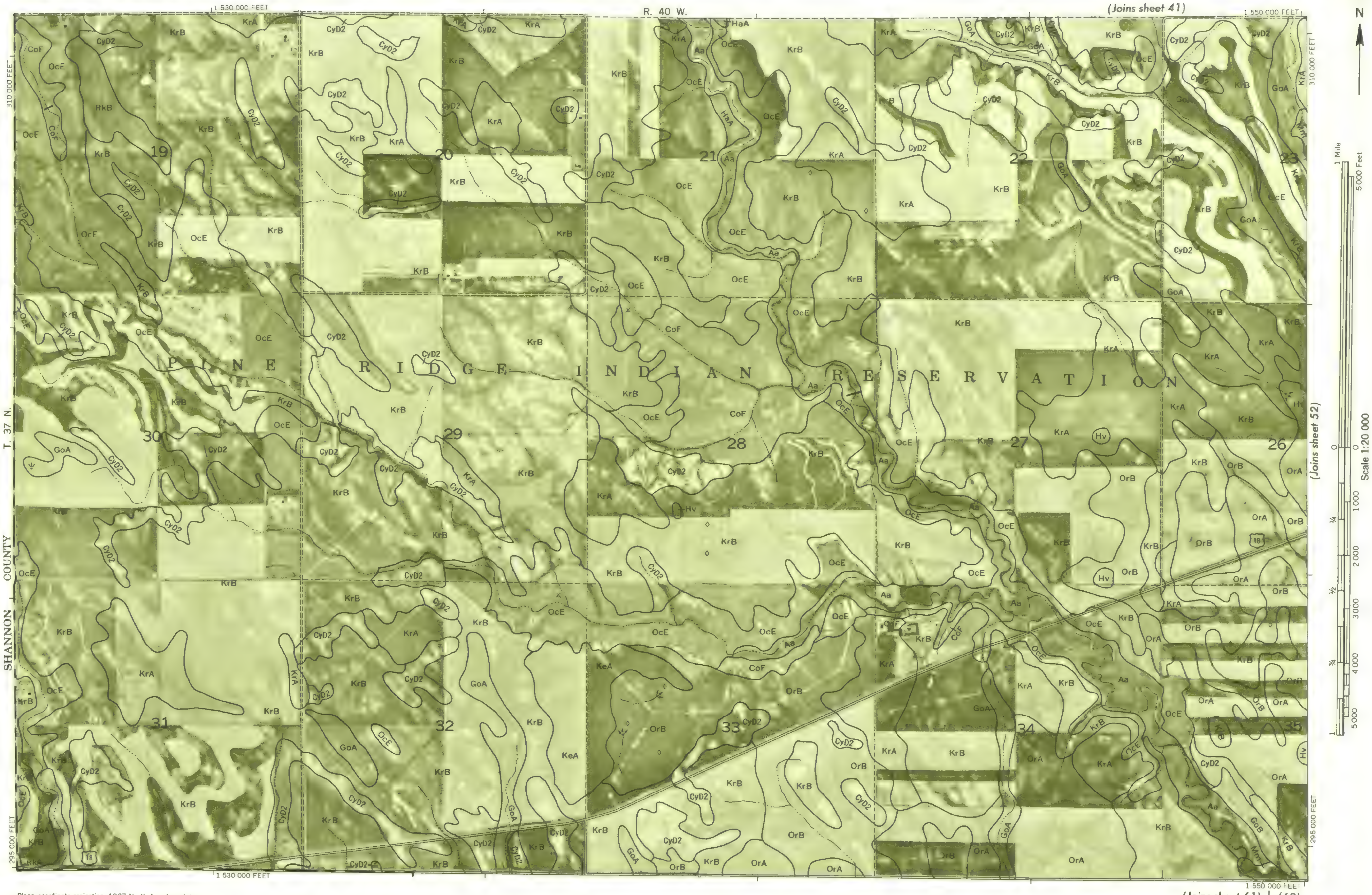
Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs and the South Dakota Agricultural Experiment Station.

Plane coordinate projection. 1927 North American datum. 5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station
Land division corners are approximately positioned on this map.

BENNETT COUNTY, SOUTH DAKOTA NO. 51



Plane coordinate projection. 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

BENNETT COUNTY, SOUTH DAKOTA — SHEET NUMBER 52

Plane coordinate projection. 1927 North American datum. 5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

BENNETT COUNTY, SOUTH DAKOTA NO. 52

Land division corners are approximately positioned on this map.

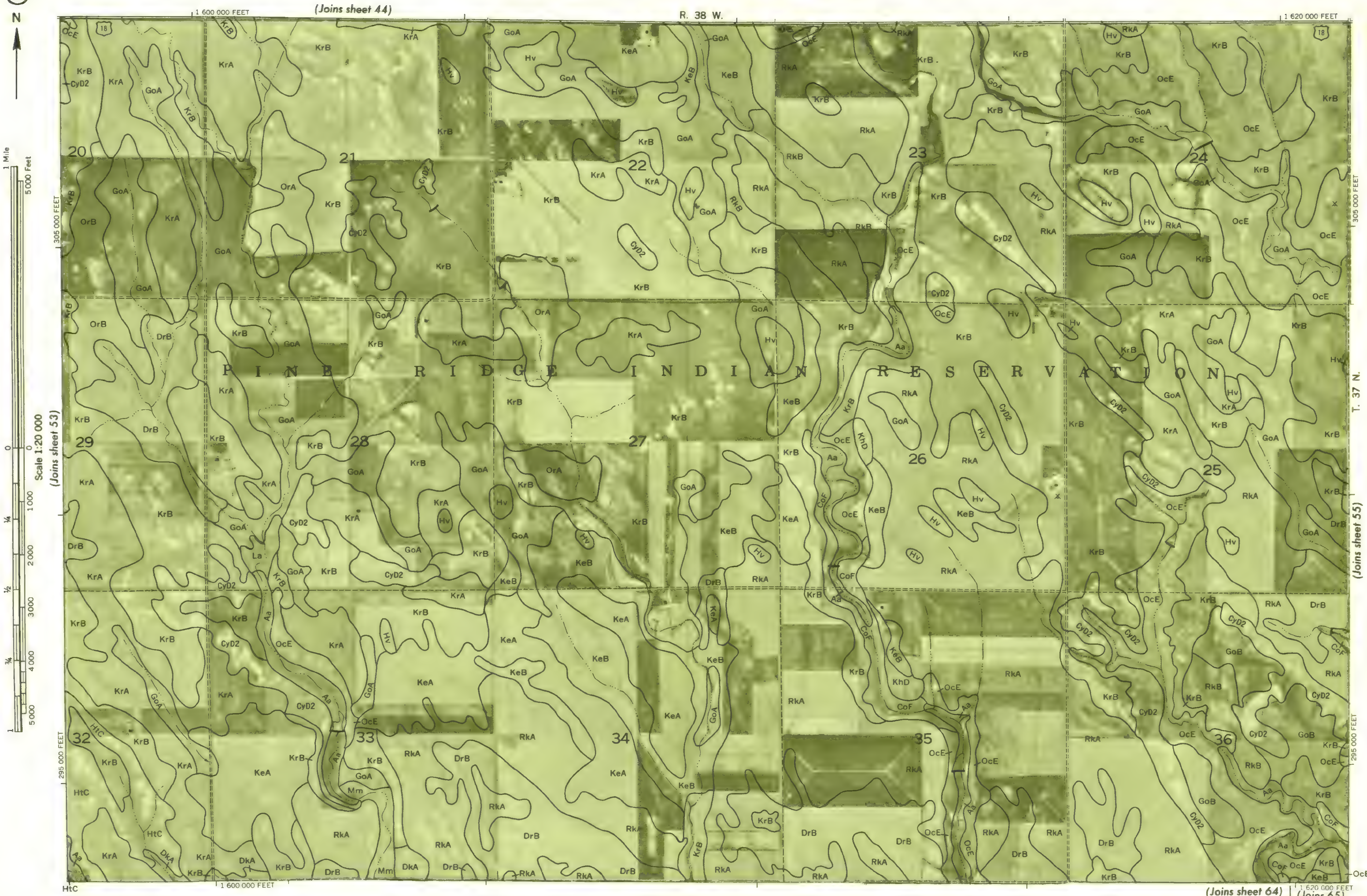
This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs and the South Dakota Agricultural Experiment Station.

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

Plane coordinate projection. 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

BENNETT COUNTY, SOUTH DAKOTA — SHEET NUMBER 54

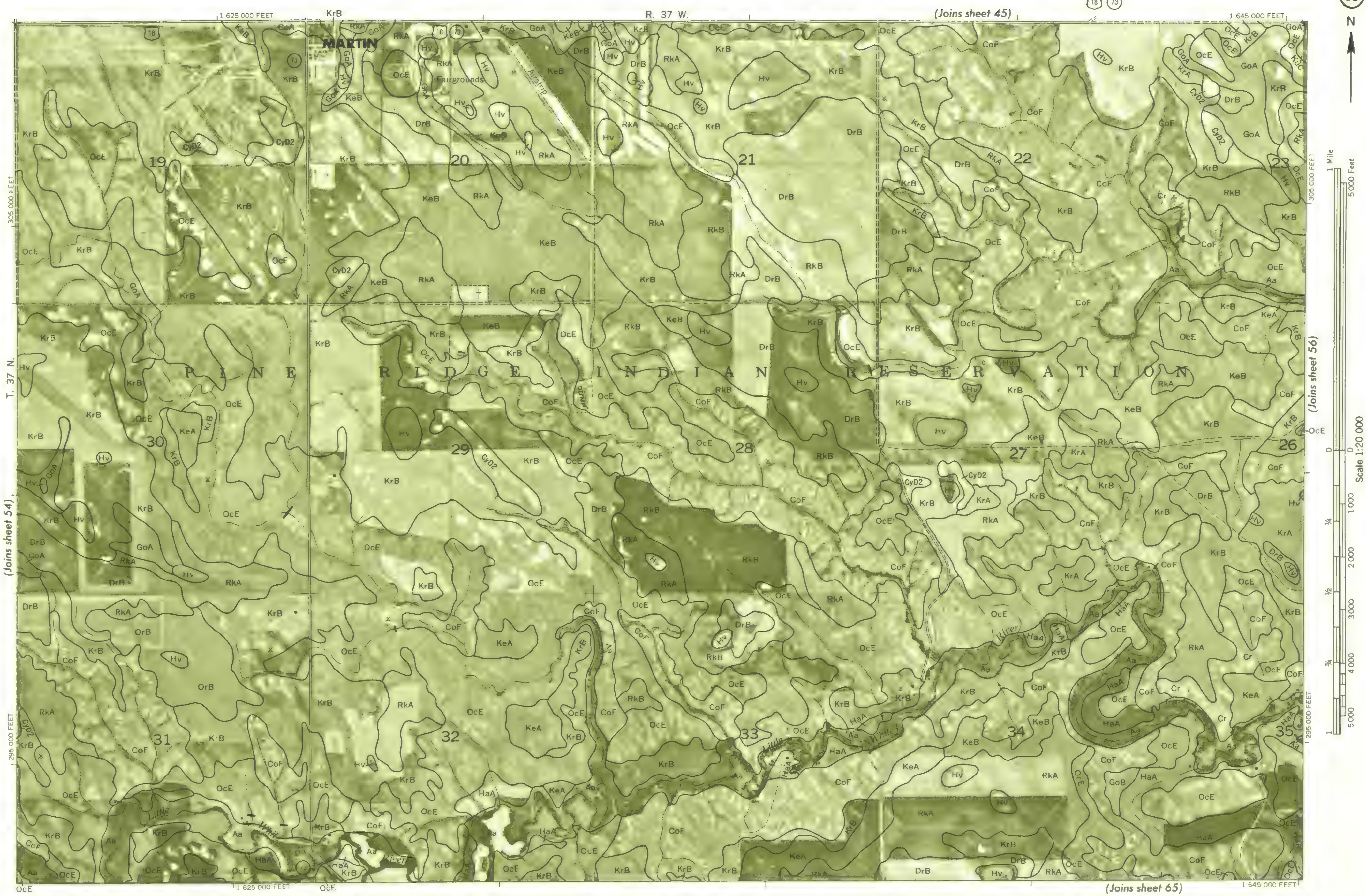


Plane coordinate projection. 1927 North American datum
5,000-foot grid ticks based on South Dakota coordinate system,
south zone. Mosaic compiled from 1961 aerial photographs.

BENNETT COUNTY, SOUTH DAKOTA NO. 54

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs and the South Dakota Agricultural Experiment Station.



Plane coordinate projection 1927 North American datum
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

56

BENNETT COUNTY, SOUTH DAKOTA — SHEET NUMBER 56

Plane coordinate projection. 1927 North American datum. 5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

BENNETT COUNTY, SOUTH DAKOTA NO. 56

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

BENNETT COUNTY, SOUTH DAKOTA NO. 57

Plane coordinate projection. 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

Plane coordinate projection. 1927 North American datum. 5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

BENNETT COUNTY, SOUTH DAKOTA NO. 58

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs and the South Dakota Agricultural Experiment Station.

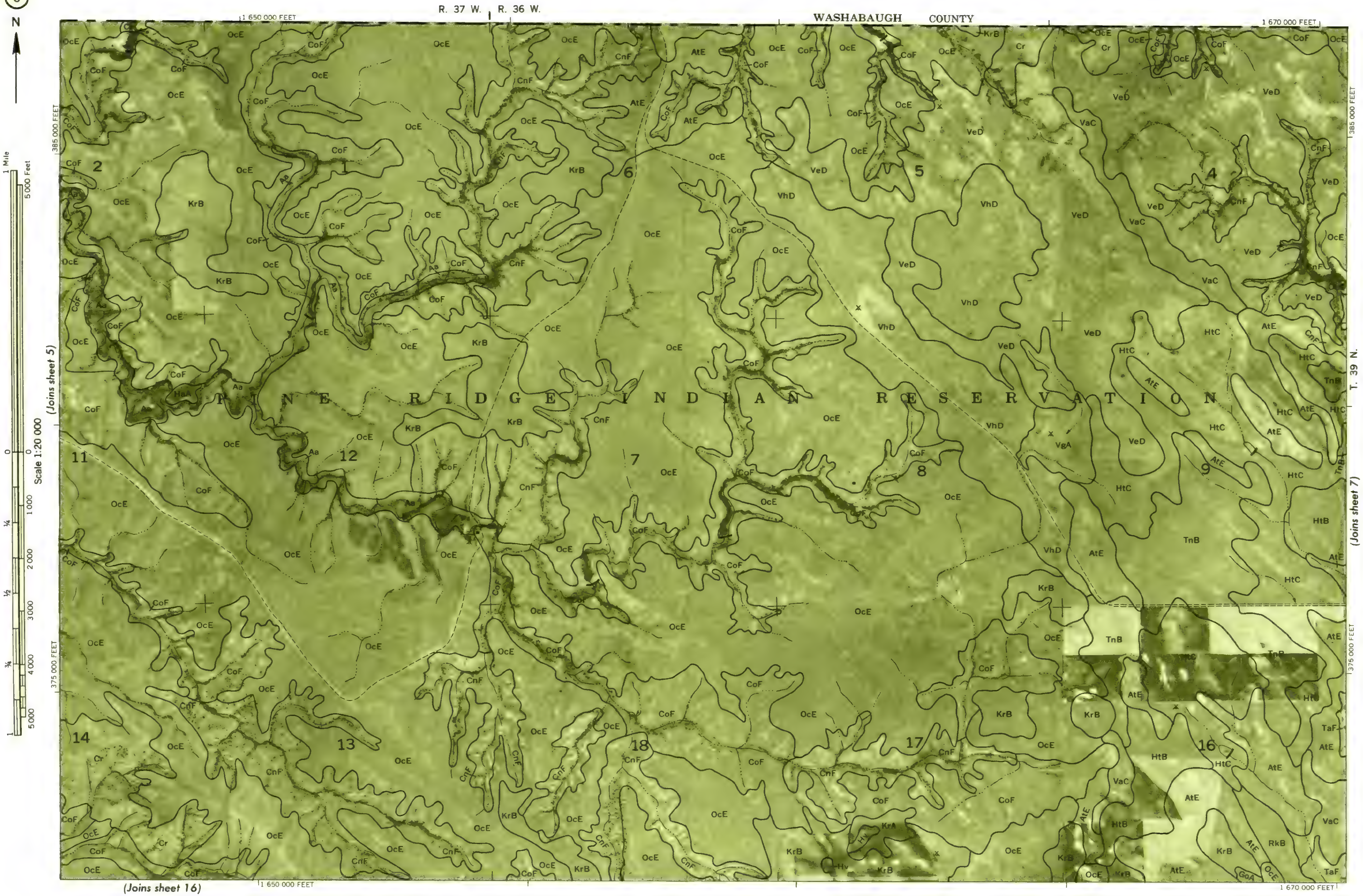
This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

BENNETT COUNTY, SOUTH DAKOTA NO. 59

Plane coordinate projection 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

BENNETT COUNTY, SOUTH DAKOTA — SHEET NUMBER 6

6



Plane coordinate projection, 1927 North American datum
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

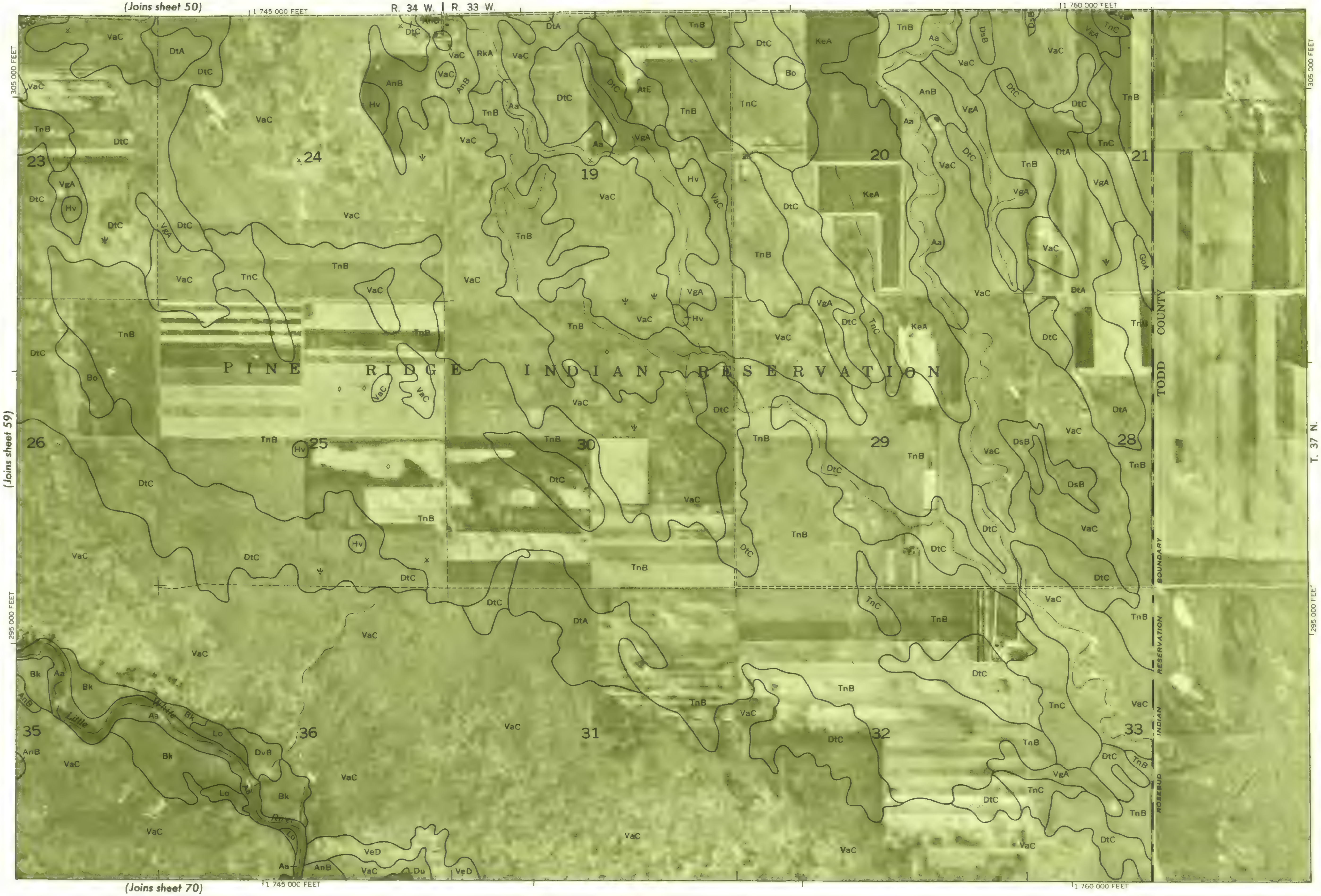
BENNETT COUNTY, SOUTH DAKOTA NO. 6

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.

BENNETT COUNTY, SOUTH DAKOTA—SHEET NUMBER 60

(Joins sheet 50)



N

1 Mile
5000 Feet
Scale 1:20 000

(Joins sheet 59)

(Joins sheet 70)

Plane coordinate projection. 1927 North American datum. 5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

BENNETT COUNTY, SOUTH DAKOTA NO. 60

Land division corners are approximately positioned on this map.

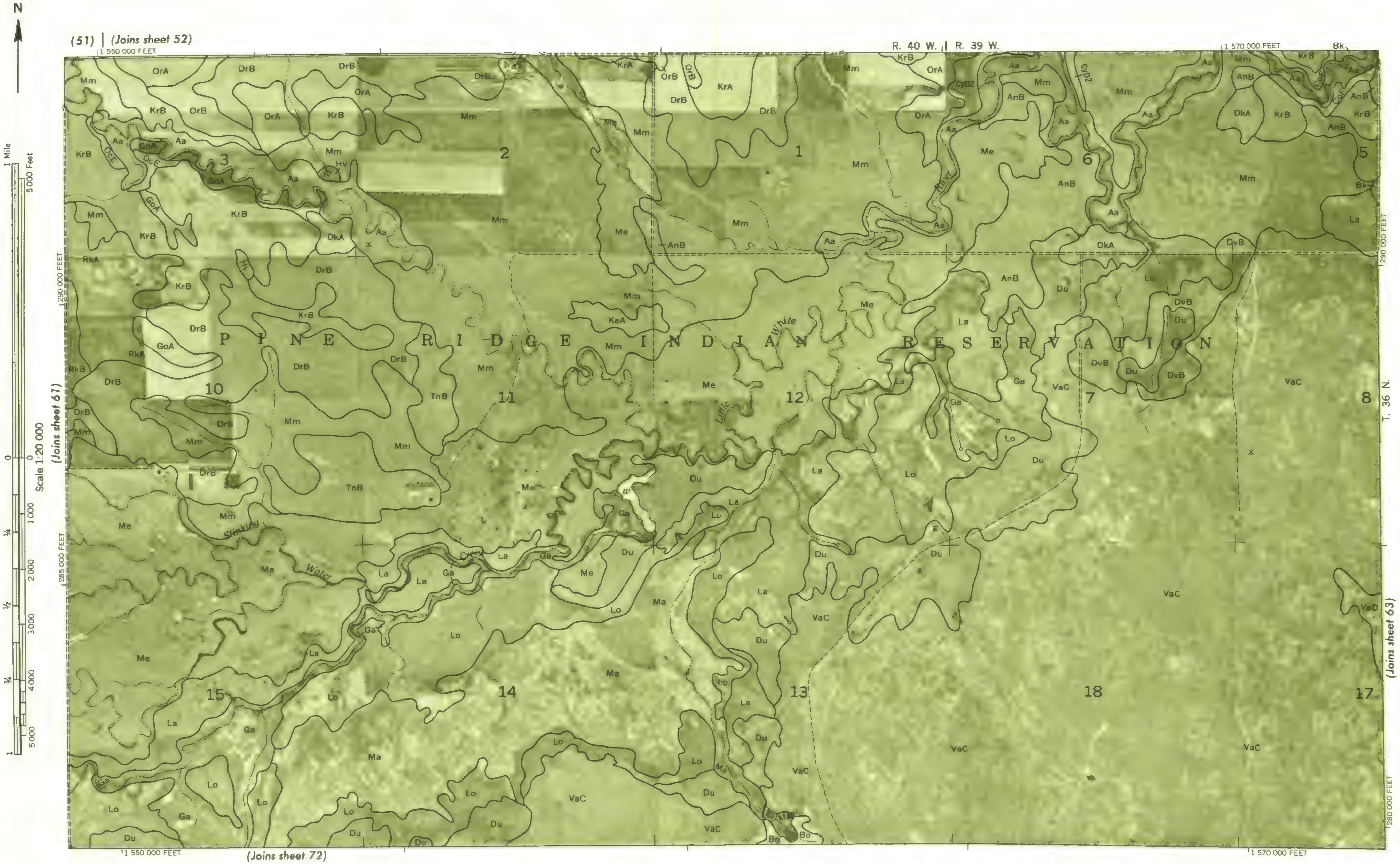
This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station
Land division corners are approximately positioned on this map.

BENNETT COUNTY, SOUTH DAKOTA NO. 61

Plane coordinate projection. 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

BENNETT COUNTY, SOUTH DAKOTA — SHEET NUMBER 62



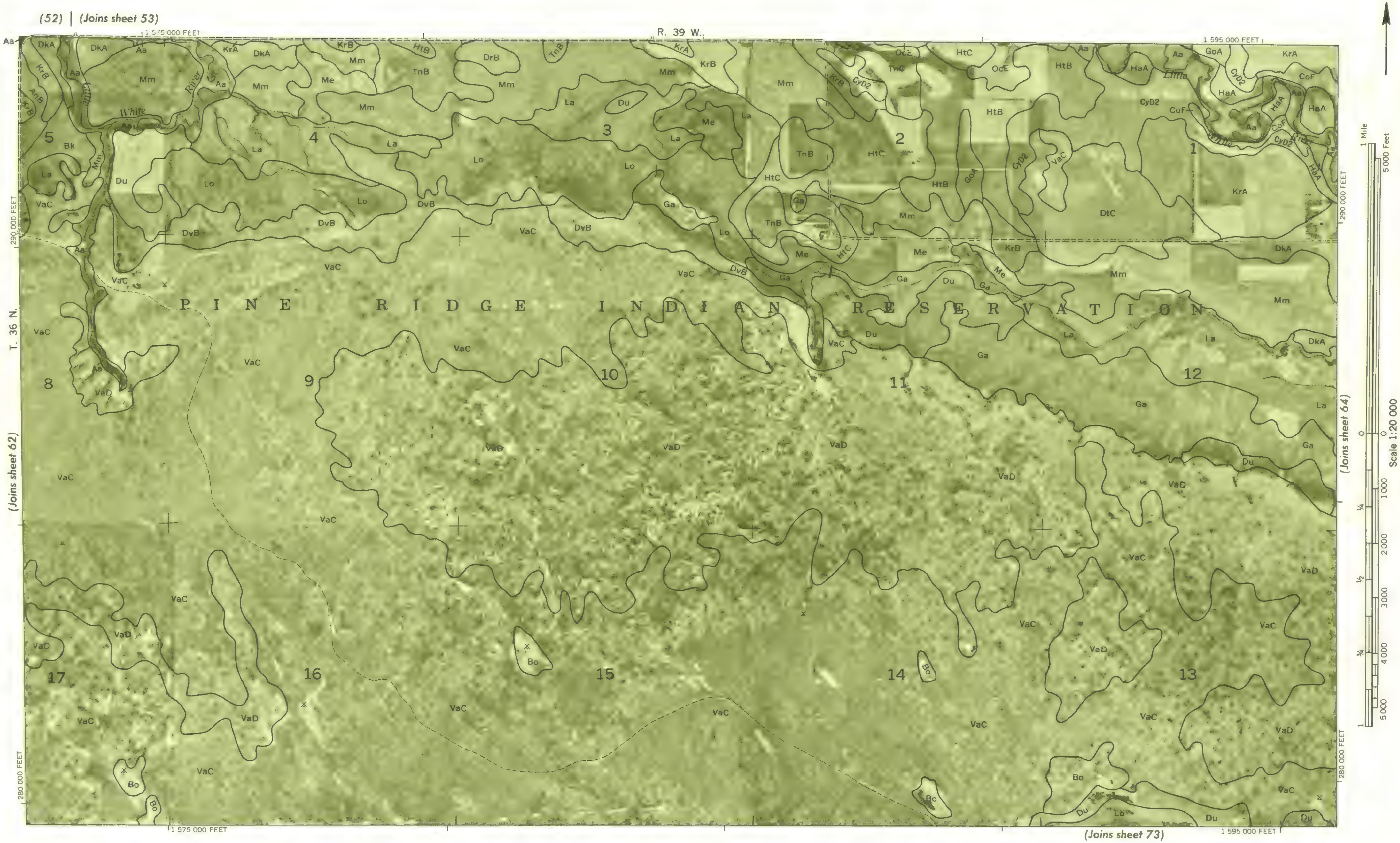
BENNETT COUNTY, SOUTH DAKOTA NO. 62

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.

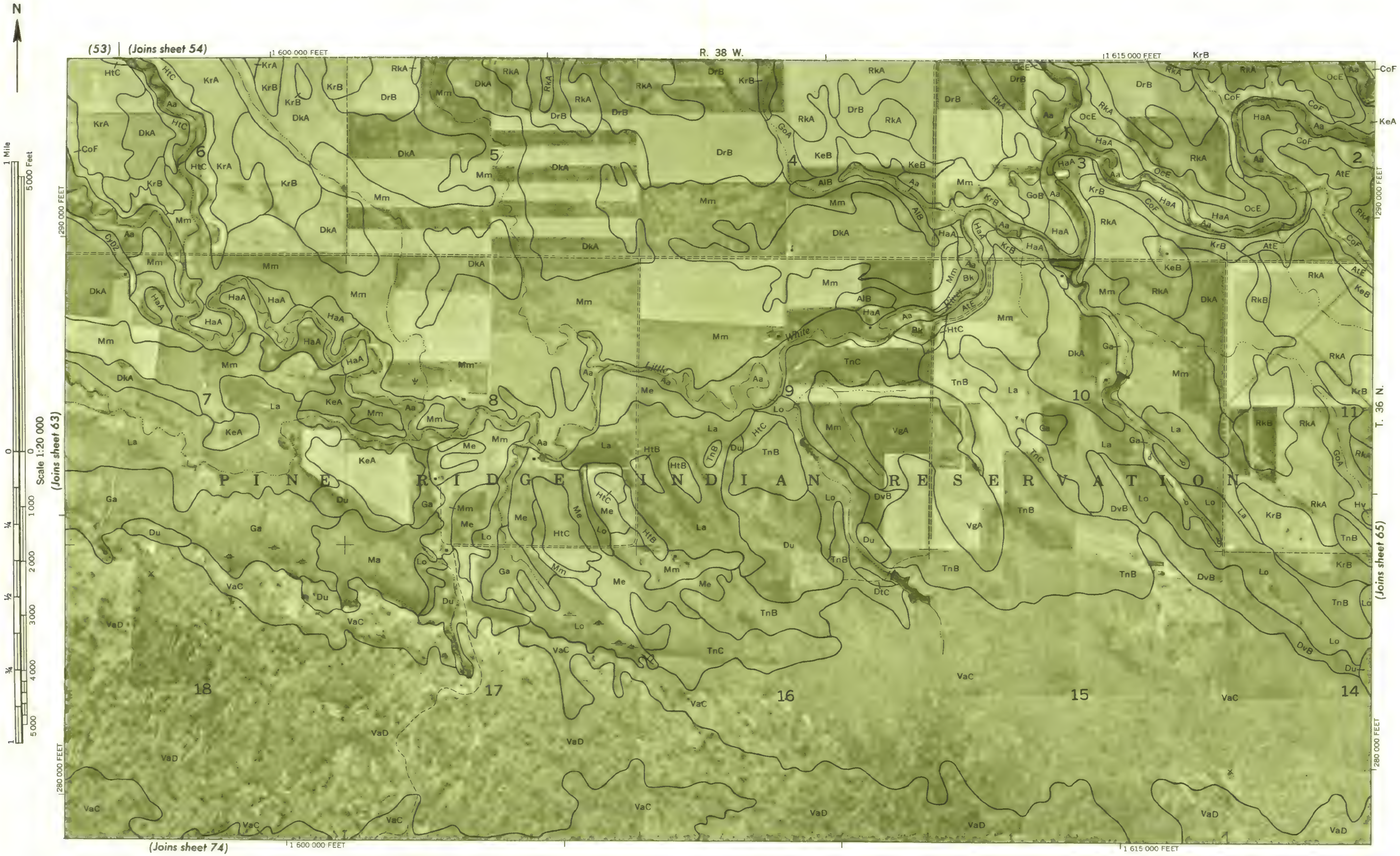
Plane coordinate projection. 1927 North American datum. 5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.



Plane coordinate projection. 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

64



BENNETT COUNTY, SOUTH DAKOTA NO. 64

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.

Plane coordinate projection. 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

BENNETT COUNTY, SOUTH DAKOTA NO. 65

Plane coordinate projection. 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

BENNETT COUNTY, SOUTH DAKOTA — SHEET NUMBER 66

BENNETT COUNTY, SOUTH DAKOTA NO. 66

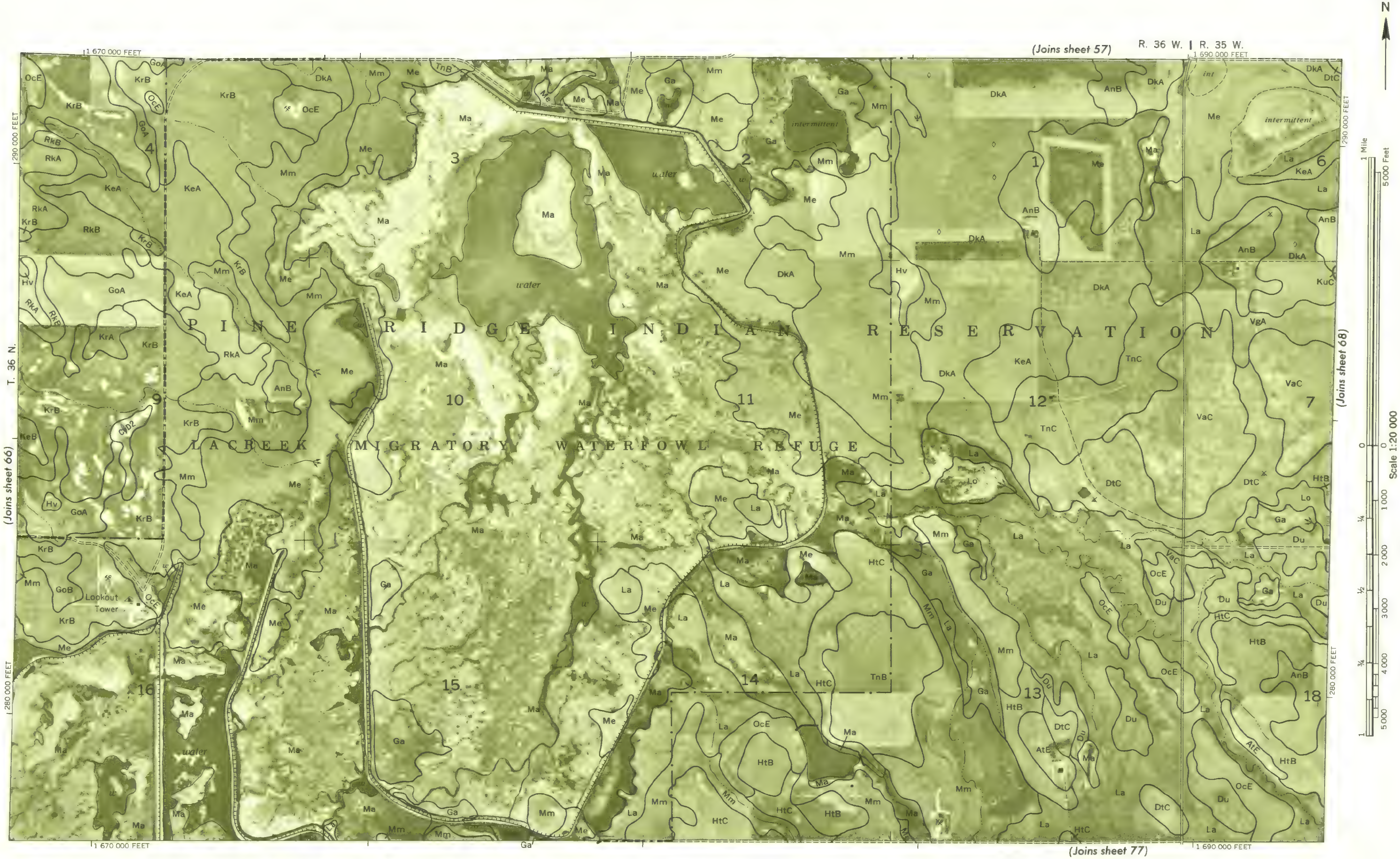
Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.

Plane coordinate projection. 1927 North American datum. 5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

BENNETT COUNTY, SOUTH DAKOTA NO. 67



Plane coordinate projection, 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

68

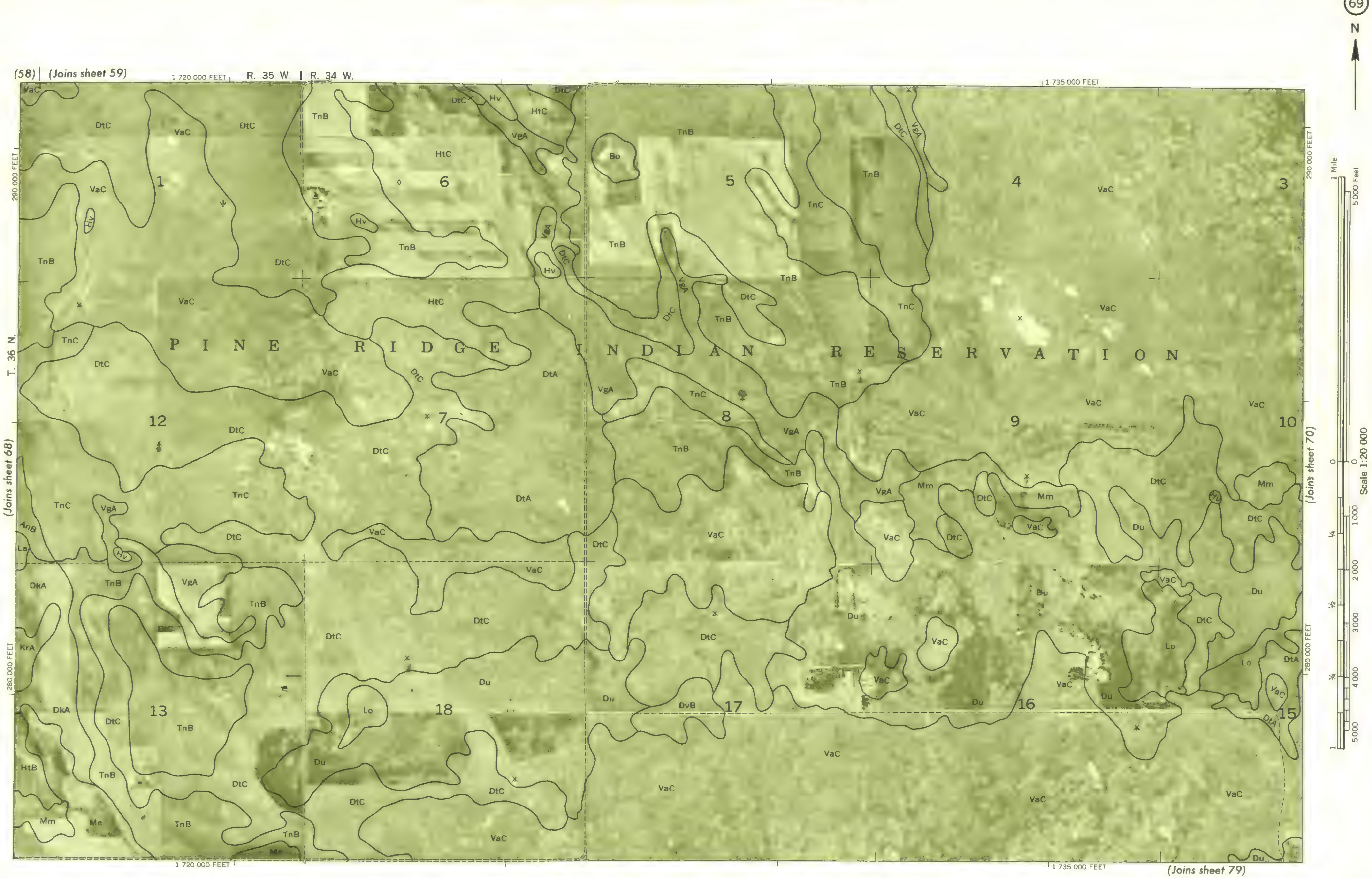
N

BENNETT COUNTY, SOUTH DAKOTA NO. 68

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.

Plane coordinate projection. 1927 North American datum
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

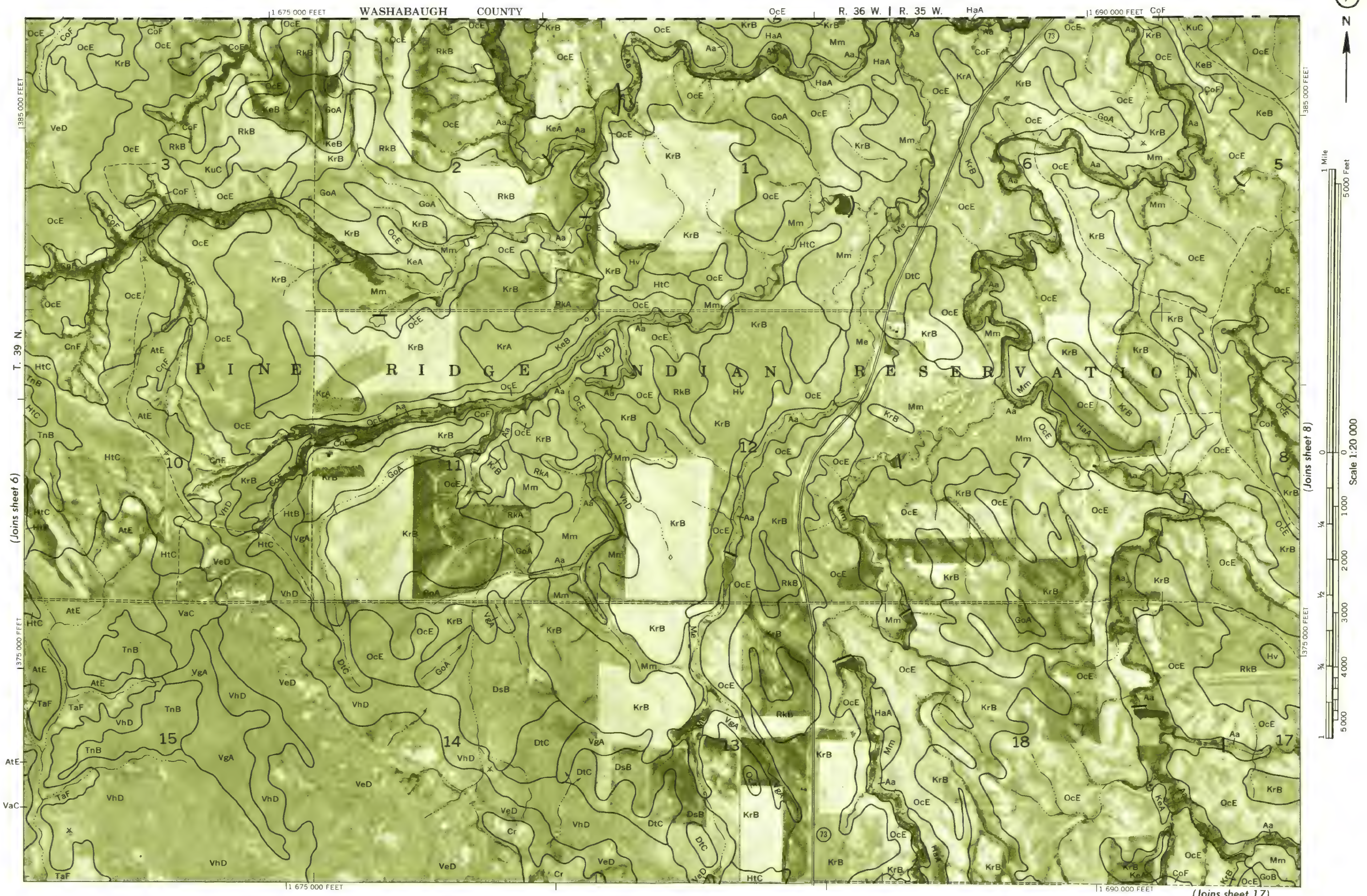


This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

BENNETT COUNTY, SOUTH DAKOTA NO. 69

Plane coordinate projection. 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

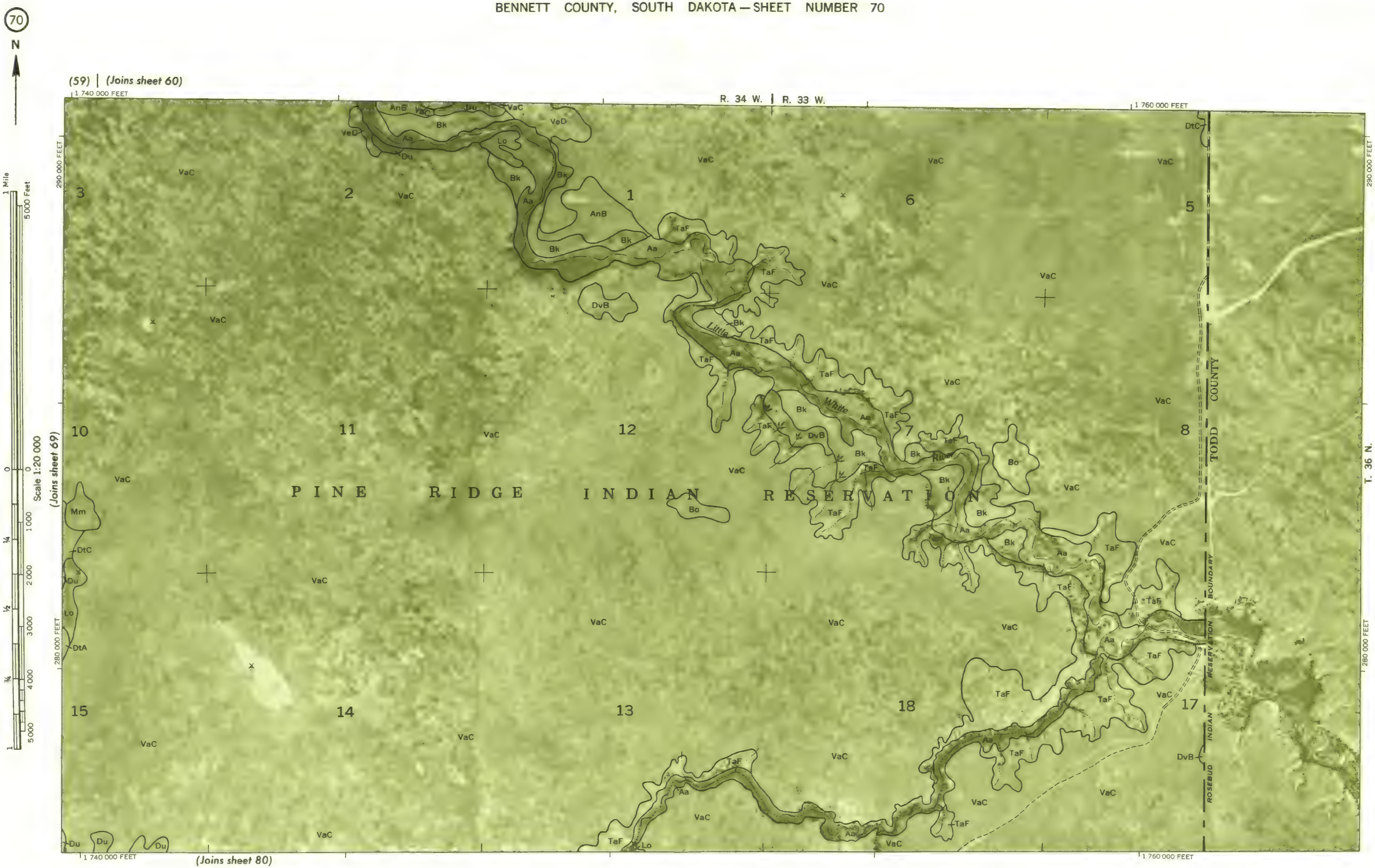


This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

BENNETT COUNTY, SOUTH DAKOTA NO. 7

Plane coordinate projection. 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs



BENNETT COUNTY, SOUTH DAKOTA NO. 70

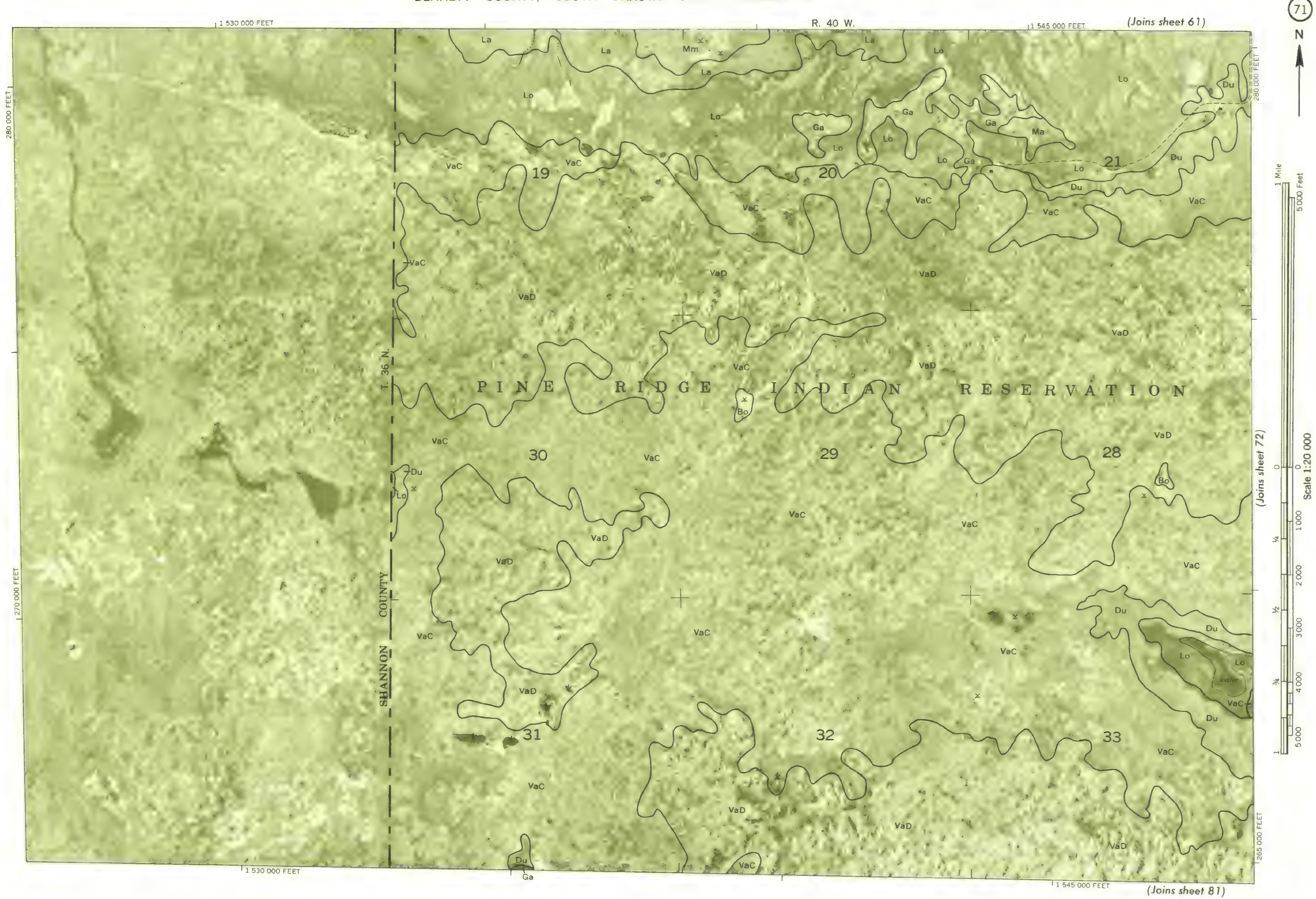
Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.

Plane coordinate projection. 1927 North American datum. 5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

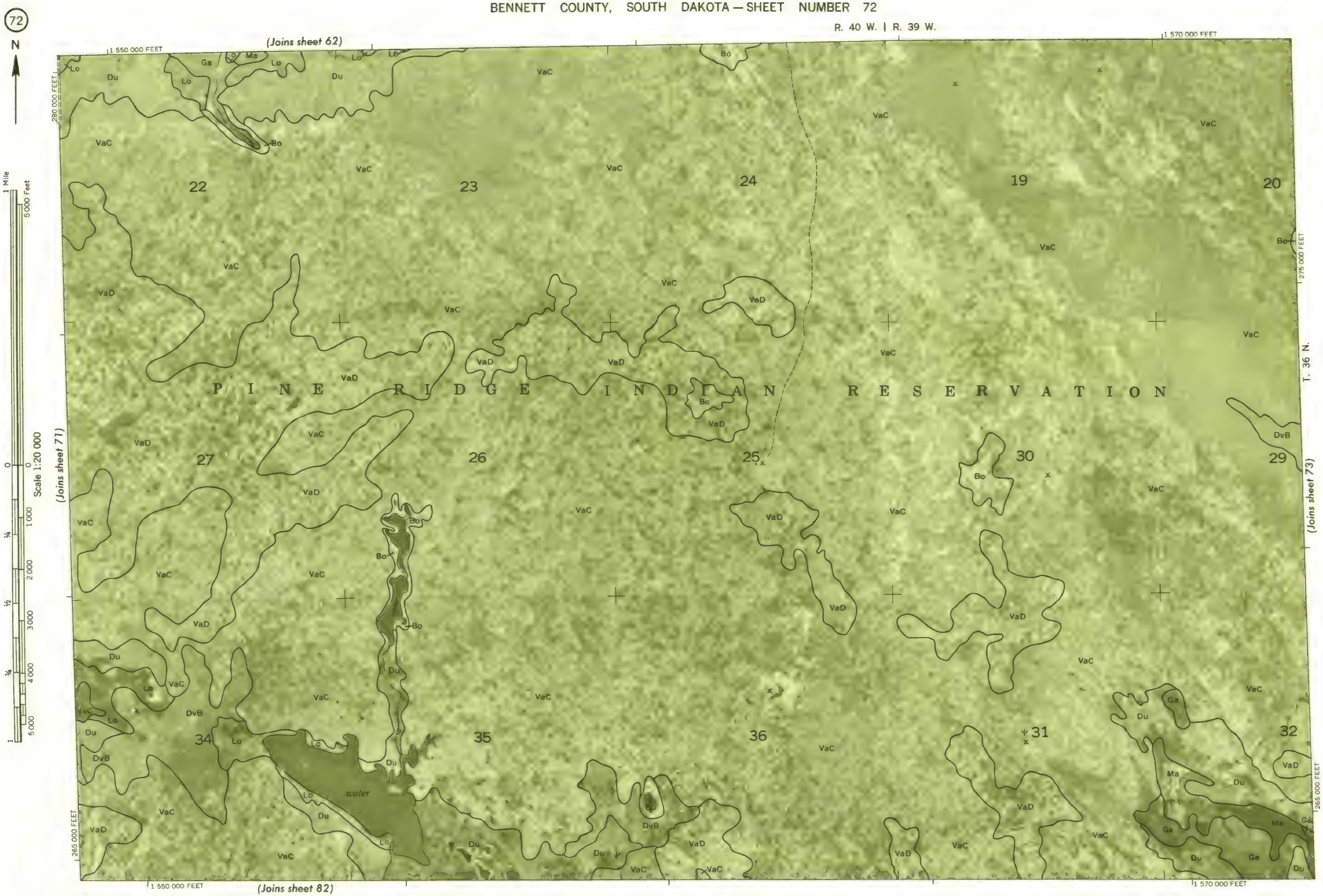
This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.

Land division corners are approximately positioned on this map.



Plane coordinate projection. 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

BENNETT COUNTY, SOUTH DAKOTA — SHEET NUMBER 72



BENNETT COUNTY, SOUTH DAKOTA NO. 72

Land division corners are approximately positioned on this map.

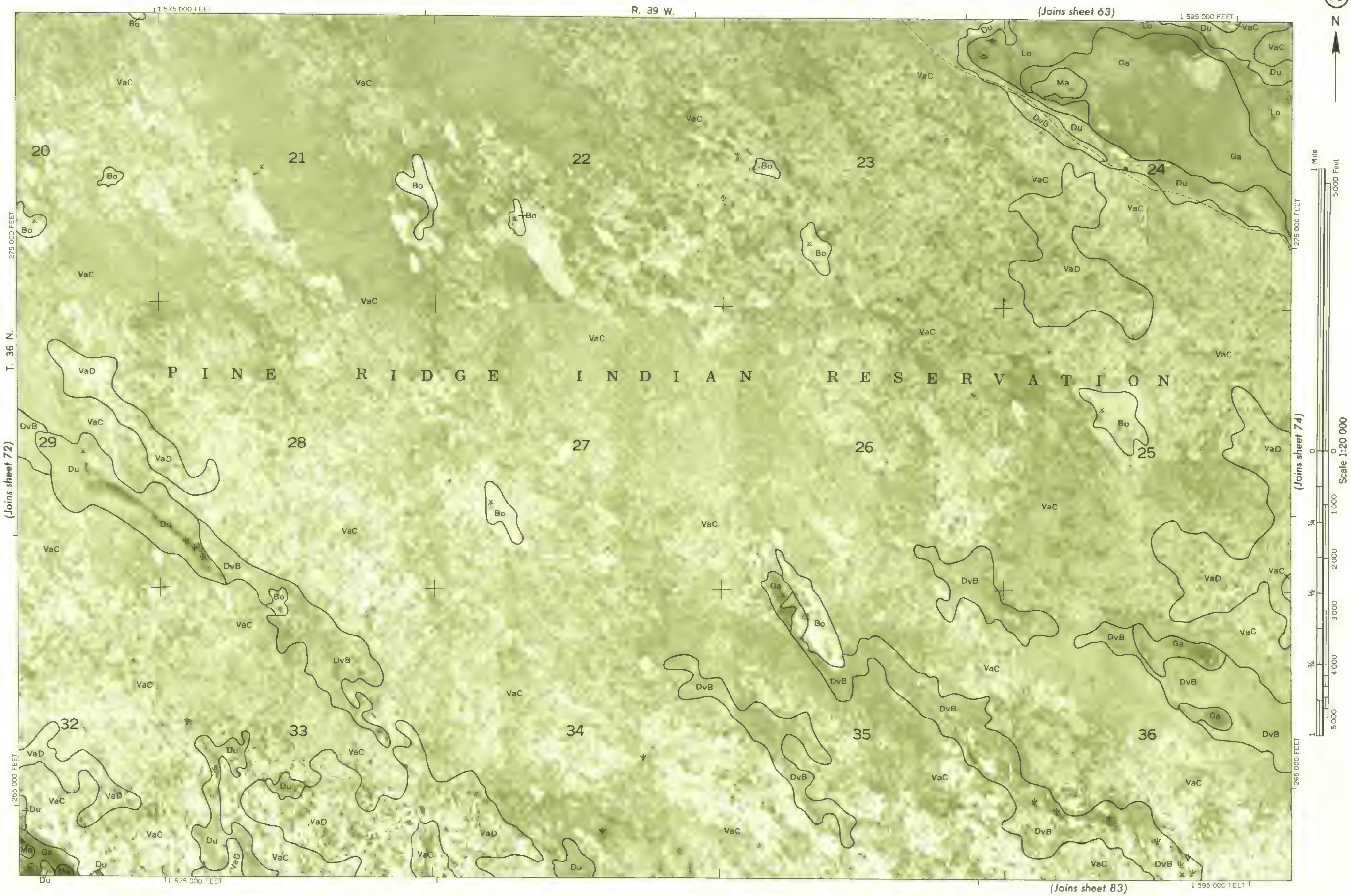
This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.

Plane coordinate projection. 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

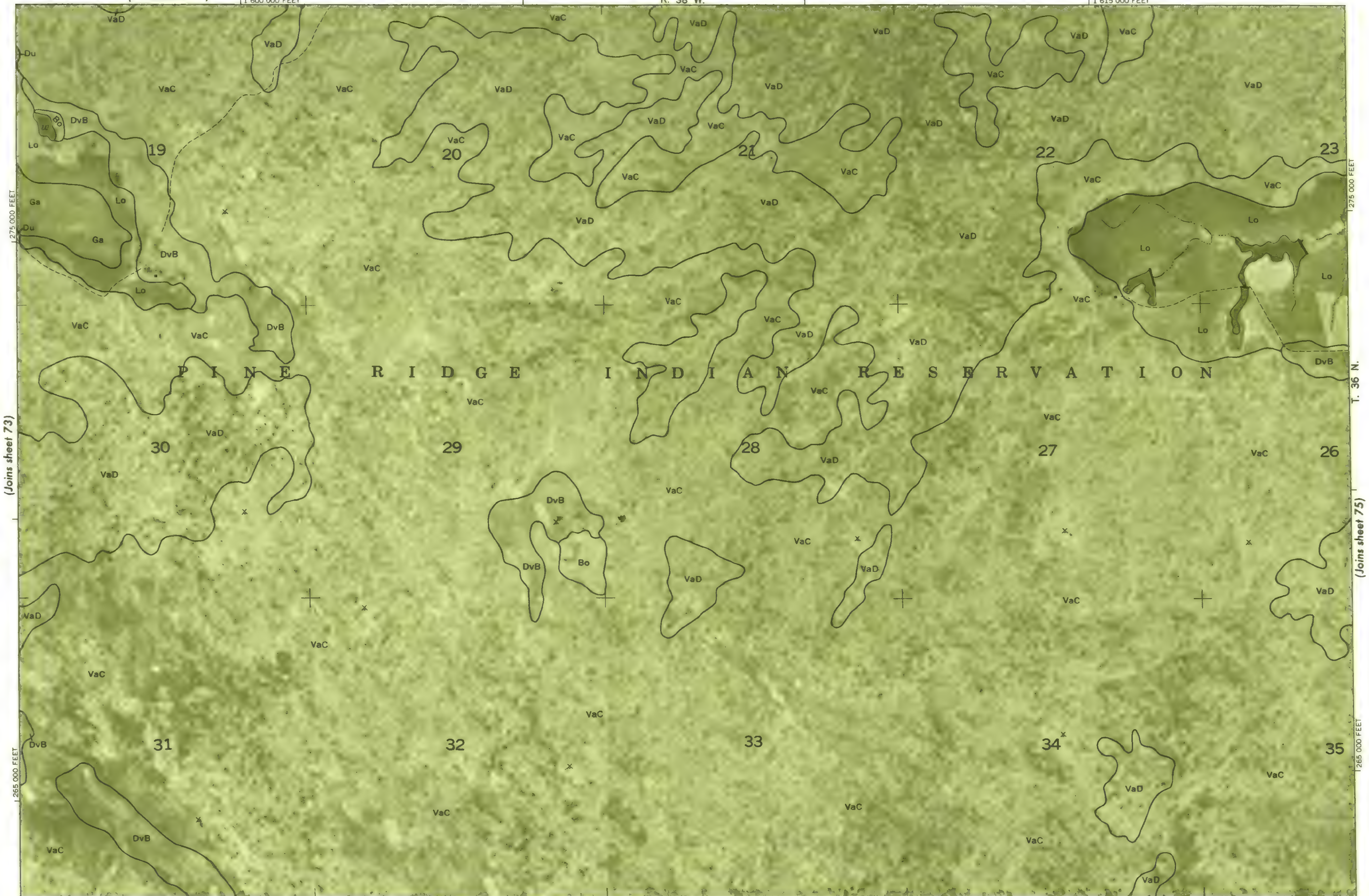
BENNETT COUNTY, SOUTH DAKOTA NO. 73



Plane coordinate projection. 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

BENNETT COUNTY, SOUTH DAKOTA — SHEET NUMBER 74

(Joins sheet 64)



(Joins sheet 73)

(Joins sheet 75)

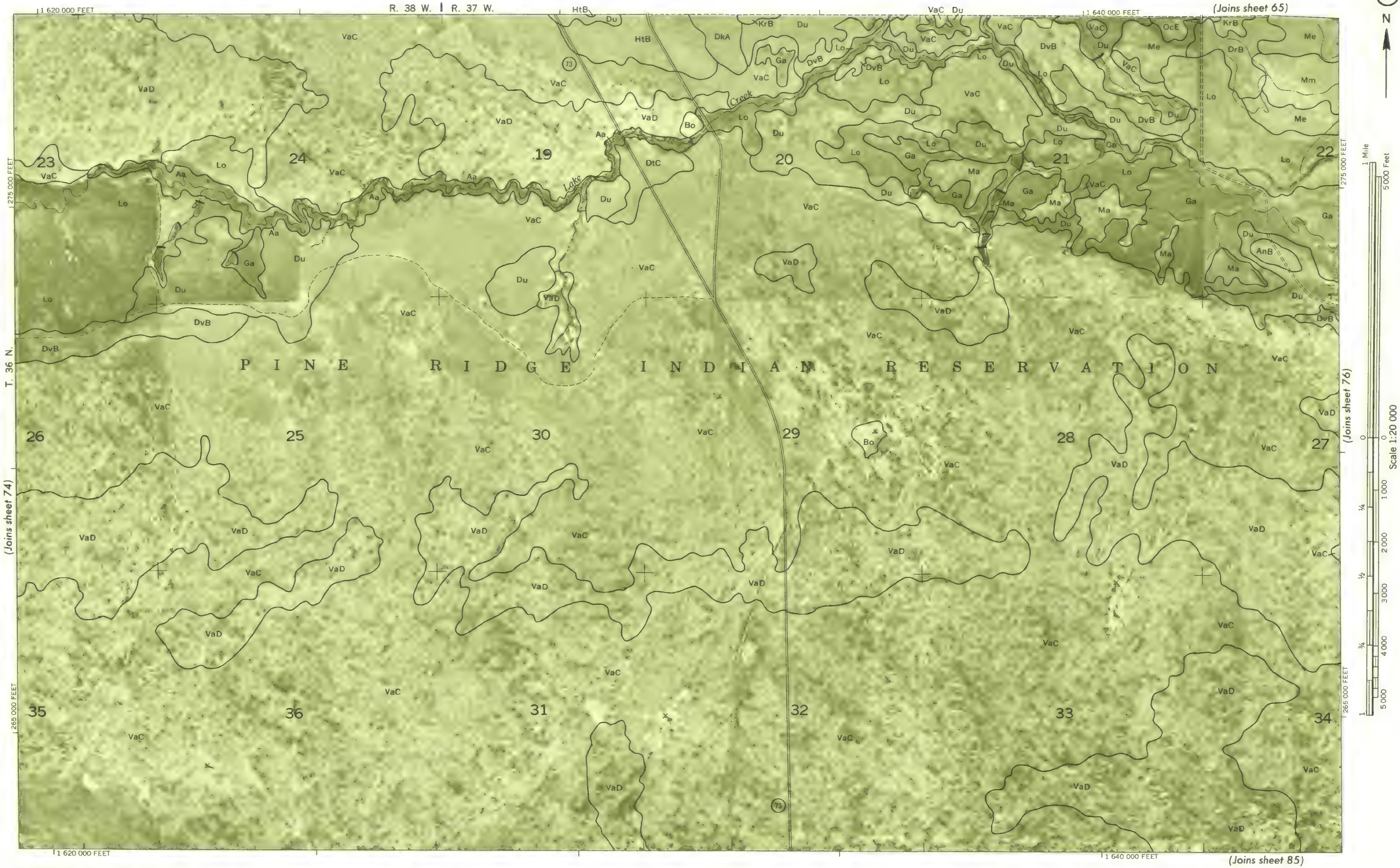
(Joins sheet 84)

Plane coordinate projection. 1927 North American datum. 5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

BENNETT COUNTY, SOUTH DAKOTA NO. 74

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.



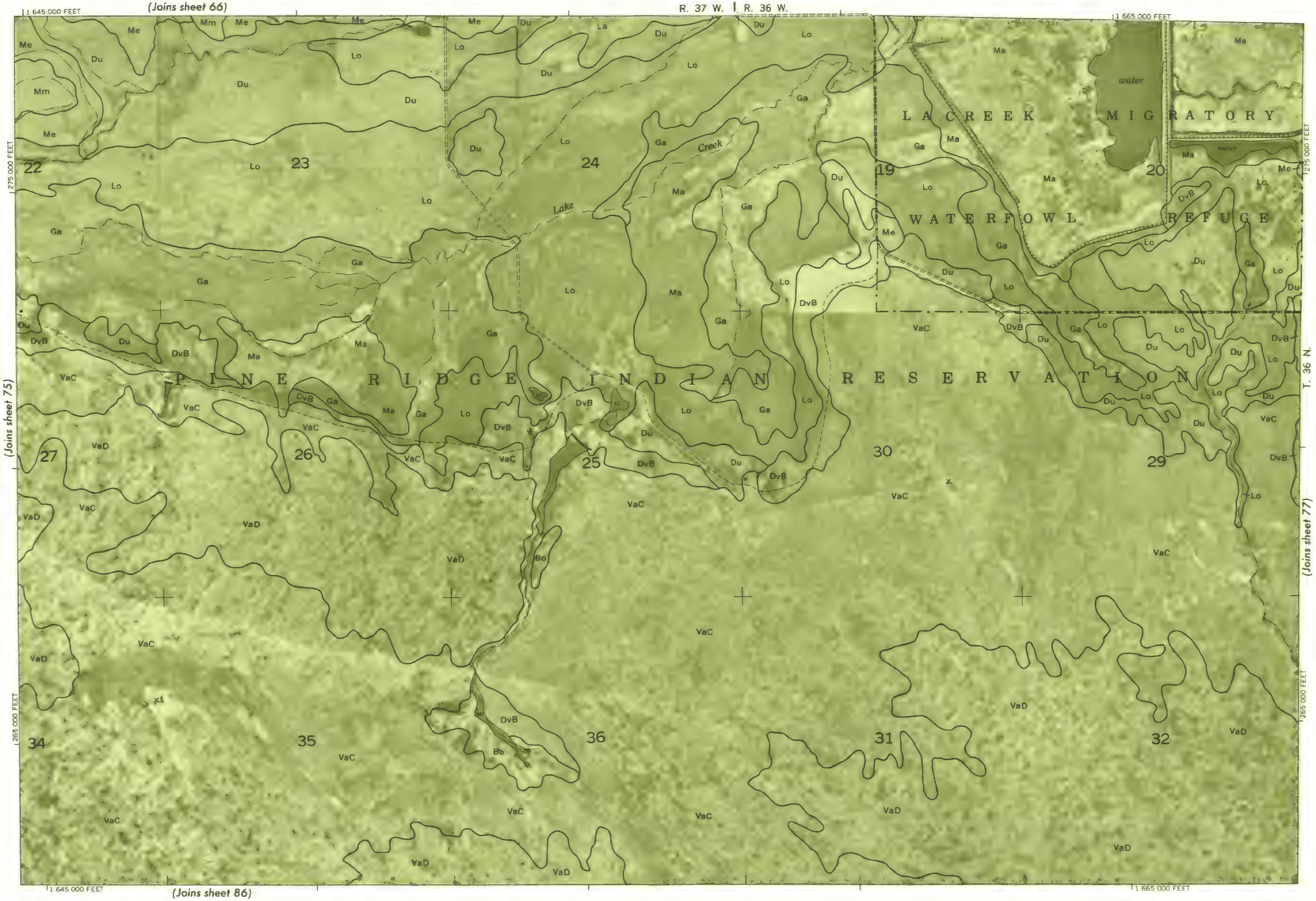
This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

Plane coordinate projection. 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

BENNETT COUNTY, SOUTH DAKOTA — SHEET NUMBER 76

N



1 Mile
5000 Feet
0
1000
2000
3000
4000
5000
Scale 1:20 000

BENNETT COUNTY, SOUTH DAKOTA NO. 76

Land division corners are approximately positioned on this map.

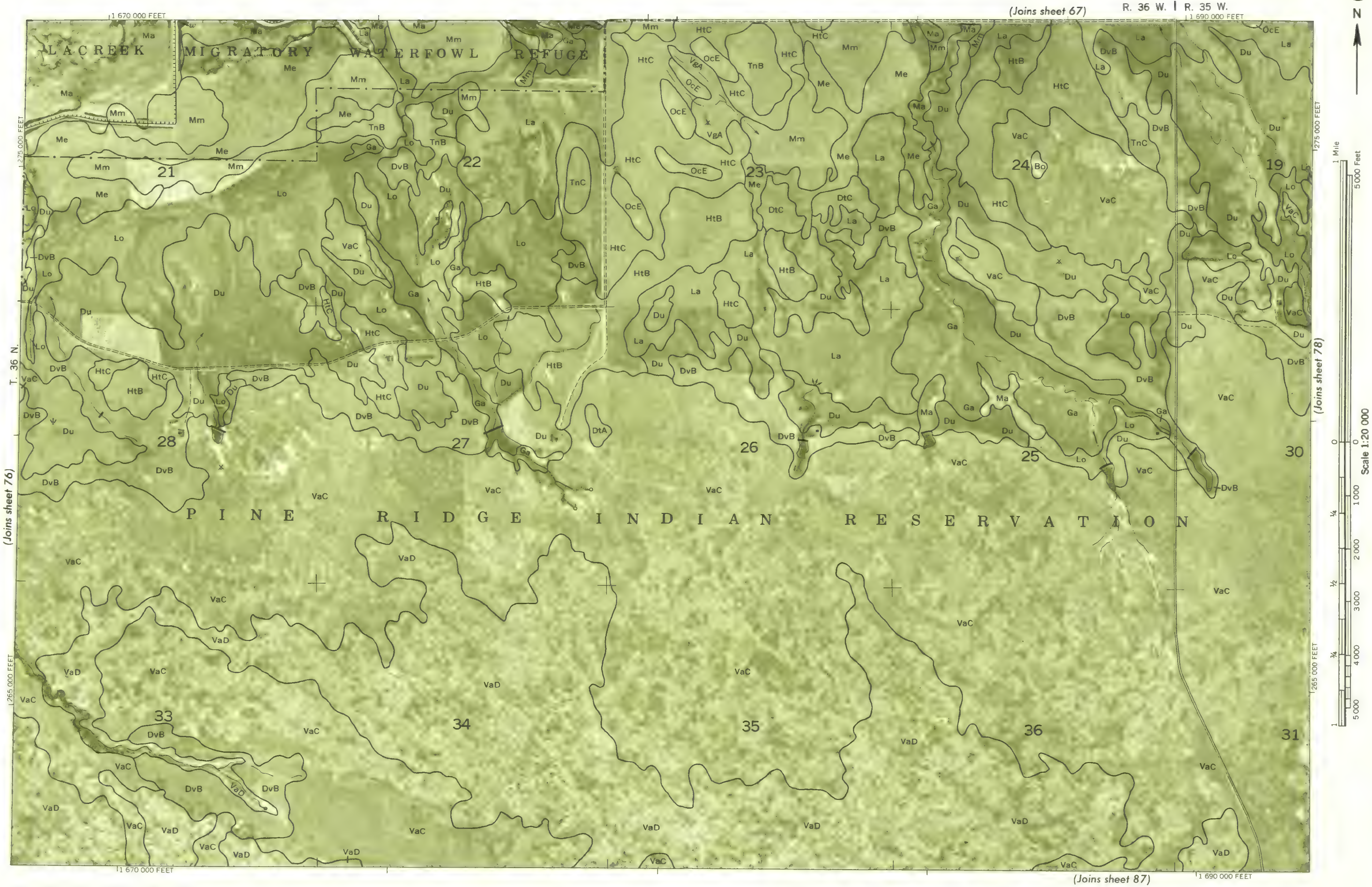
This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs and the South Dakota Agricultural Experiment Station.

Plane coordinate projection. 1927 North American datum. 5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

BENNETT COUNTY, SOUTH DAKOTA — SHEET NUMBER 77

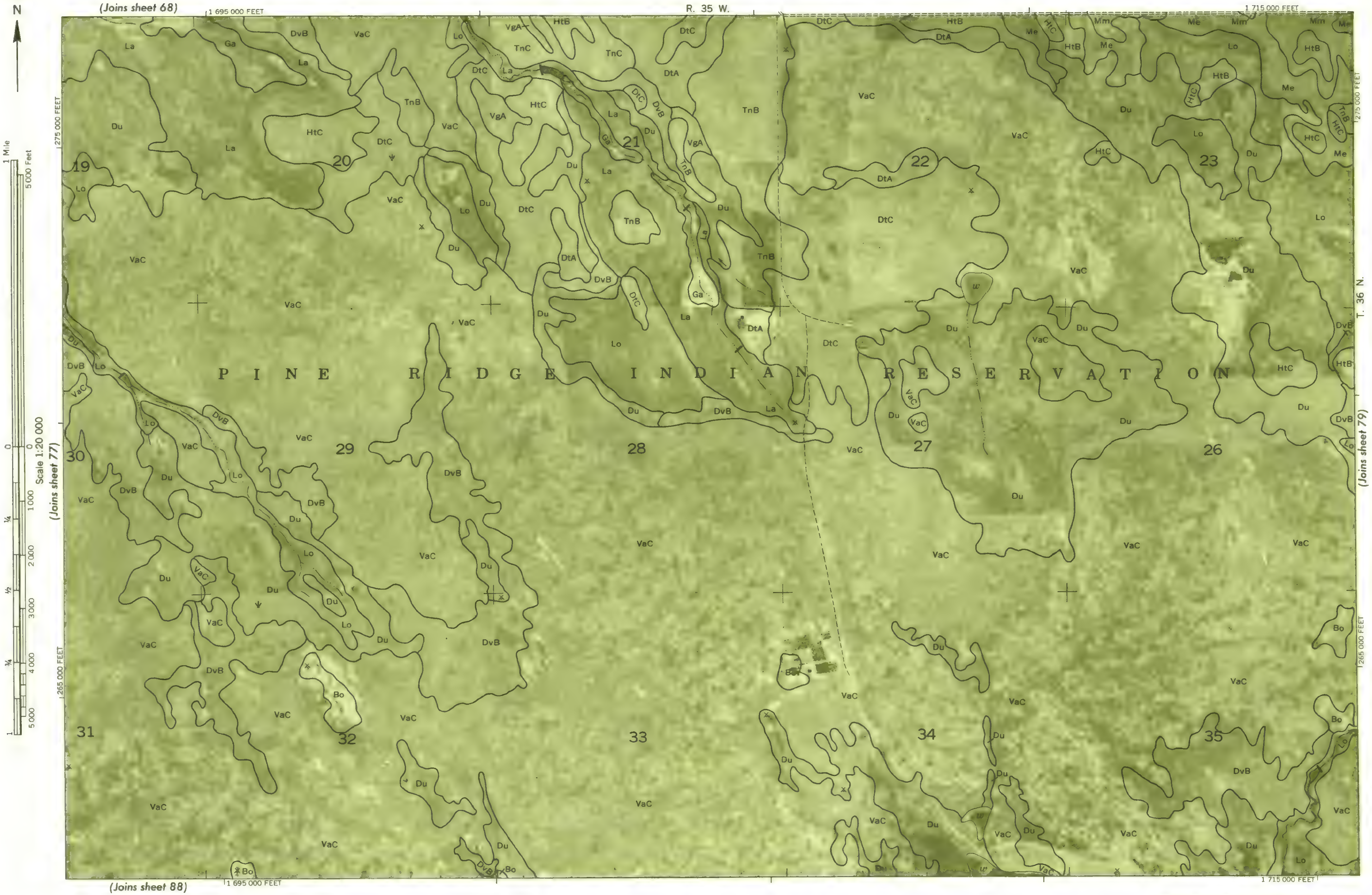
This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

BENNETT COUNTY, SOUTH DAKOTA NO. 77



Plane coordinate projection. 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

BENNETT COUNTY, SOUTH DAKOTA — SHEET NUMBER 78

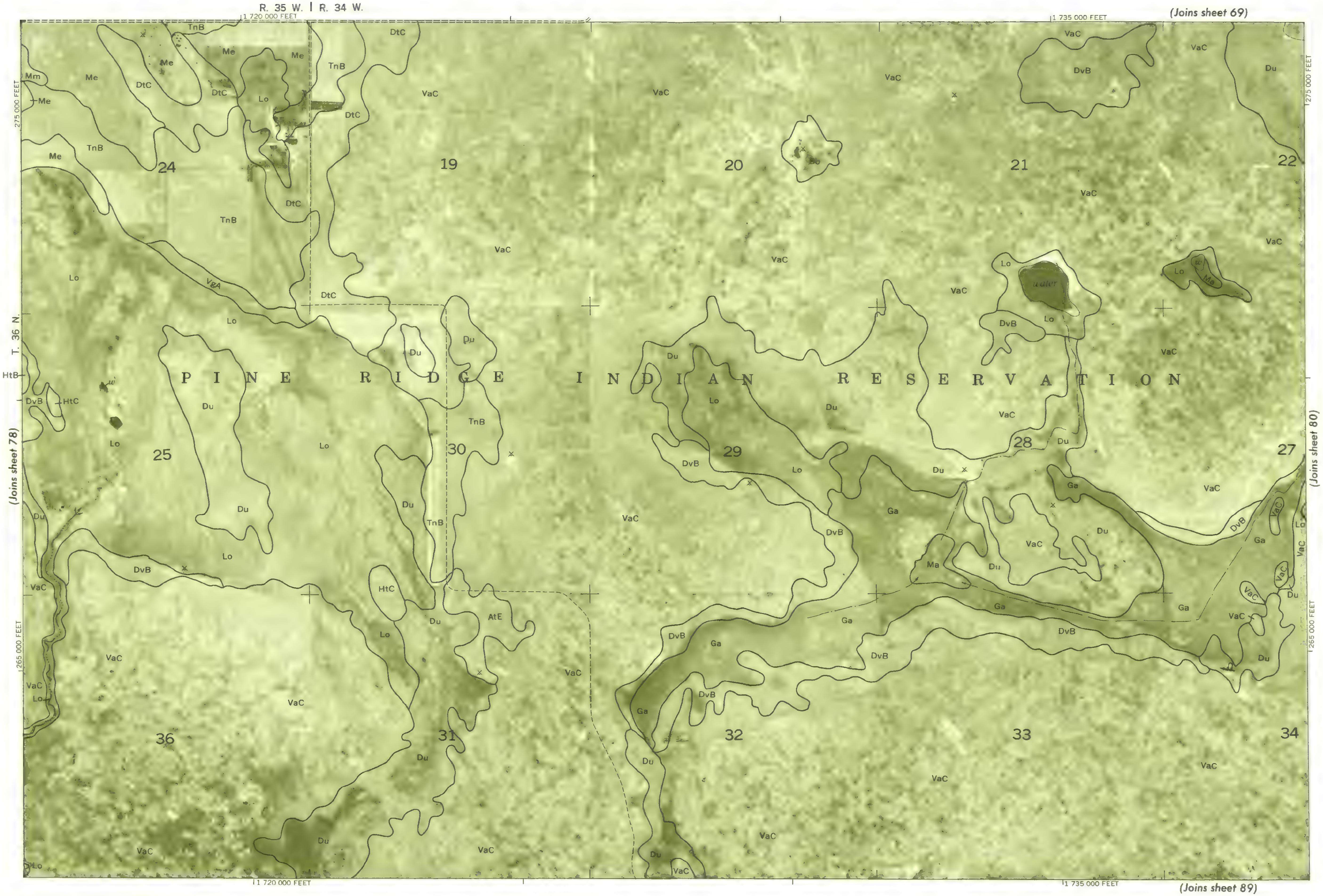


BENNETT COUNTY, SOUTH DAKOTA NO. 78

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.

Plane coordinate projection. 1927 North American datum. 5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

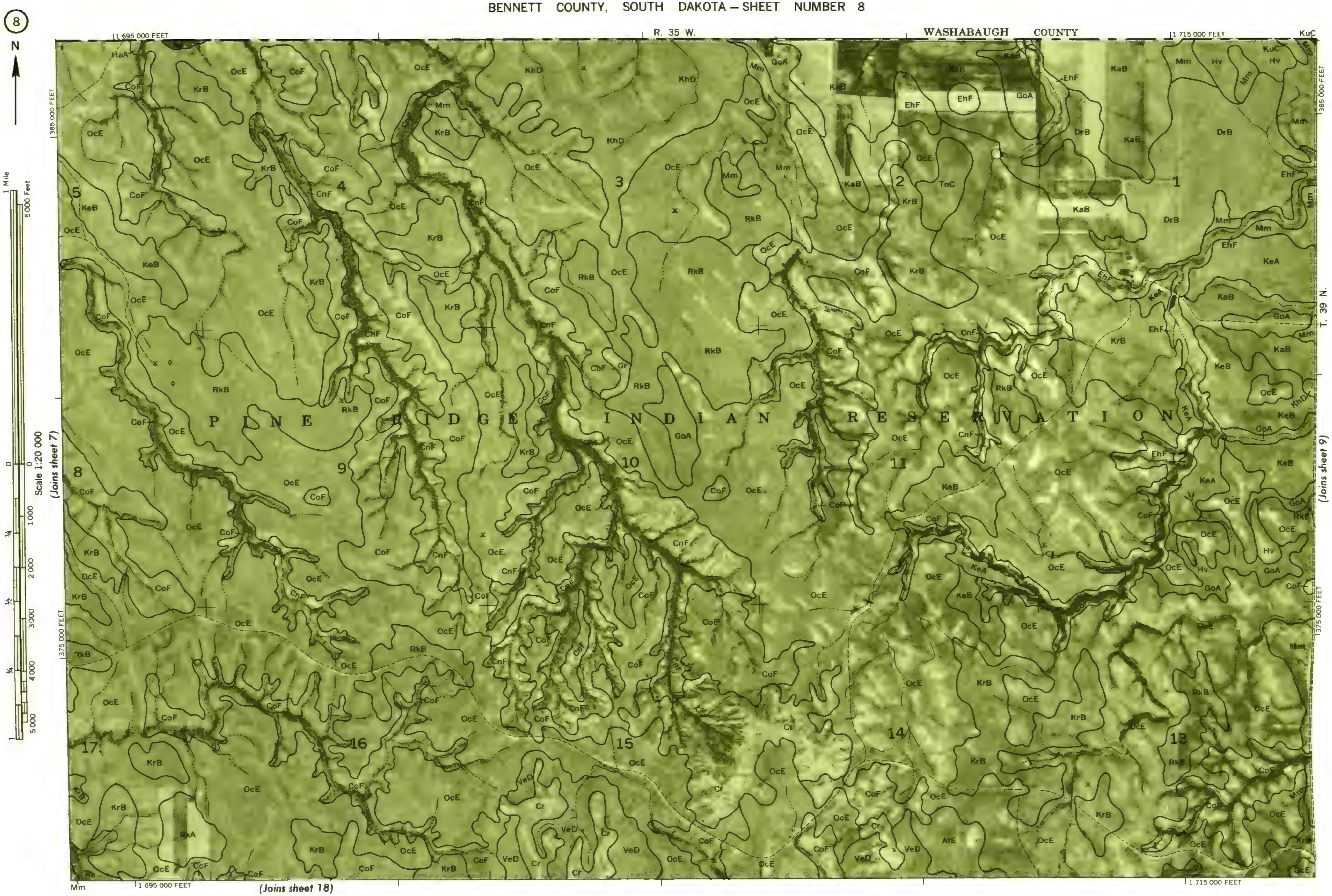


This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

Plane coordinate projection, 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

BENNETT COUNTY, SOUTH DAKOTA — SHEET NUMBER 8



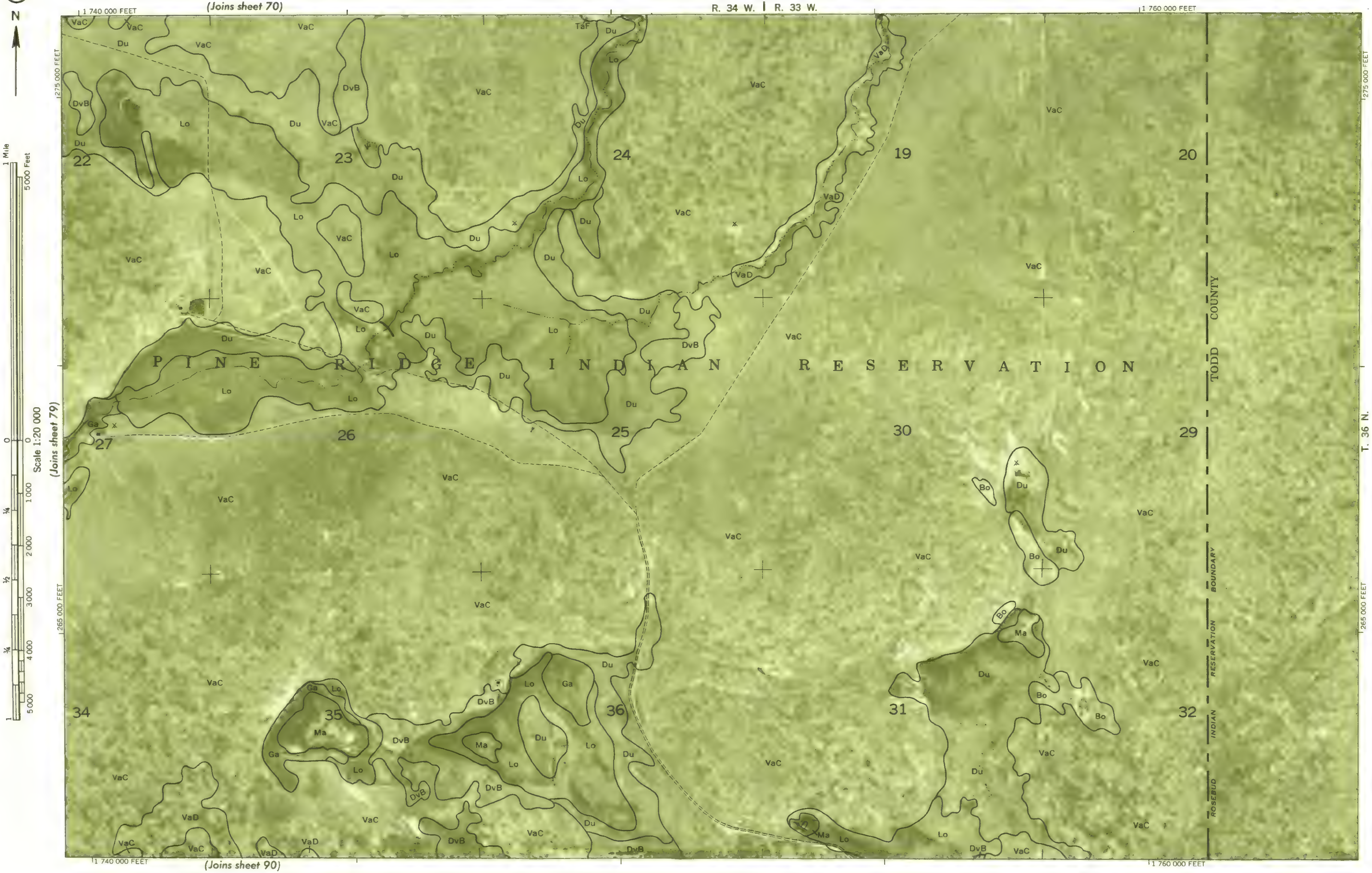
Plane coordinate projection. 1927 North American datum
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

BENNETT COUNTY, SOUTH DAKOTA NO. 8

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.

BENNETT COUNTY, SOUTH DAKOTA — SHEET NUMBER 80



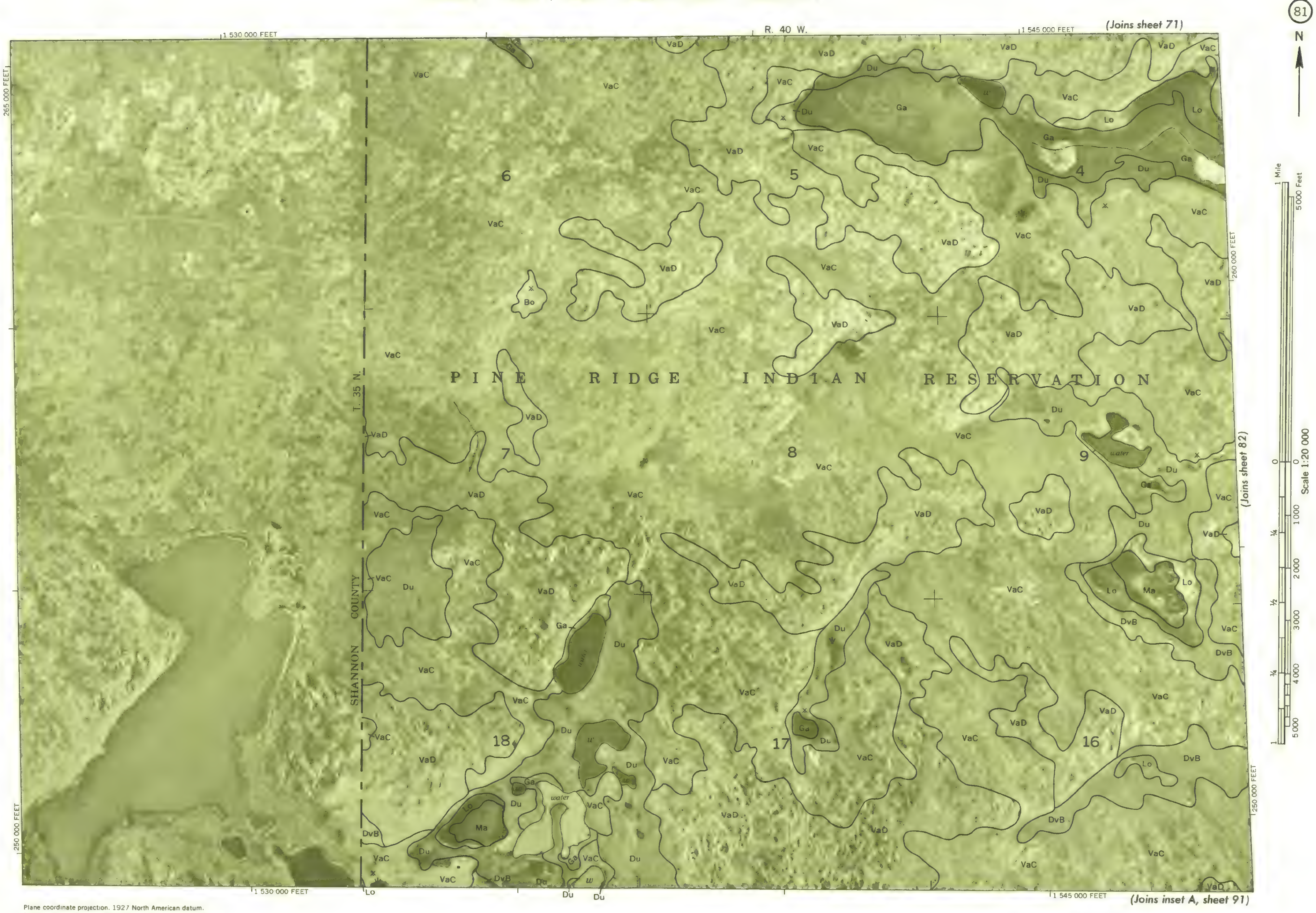
Plane coordinate projection. 1927 North American datum. 5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

BENNETT COUNTY, SOUTH DAKOTA NO. 80

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.



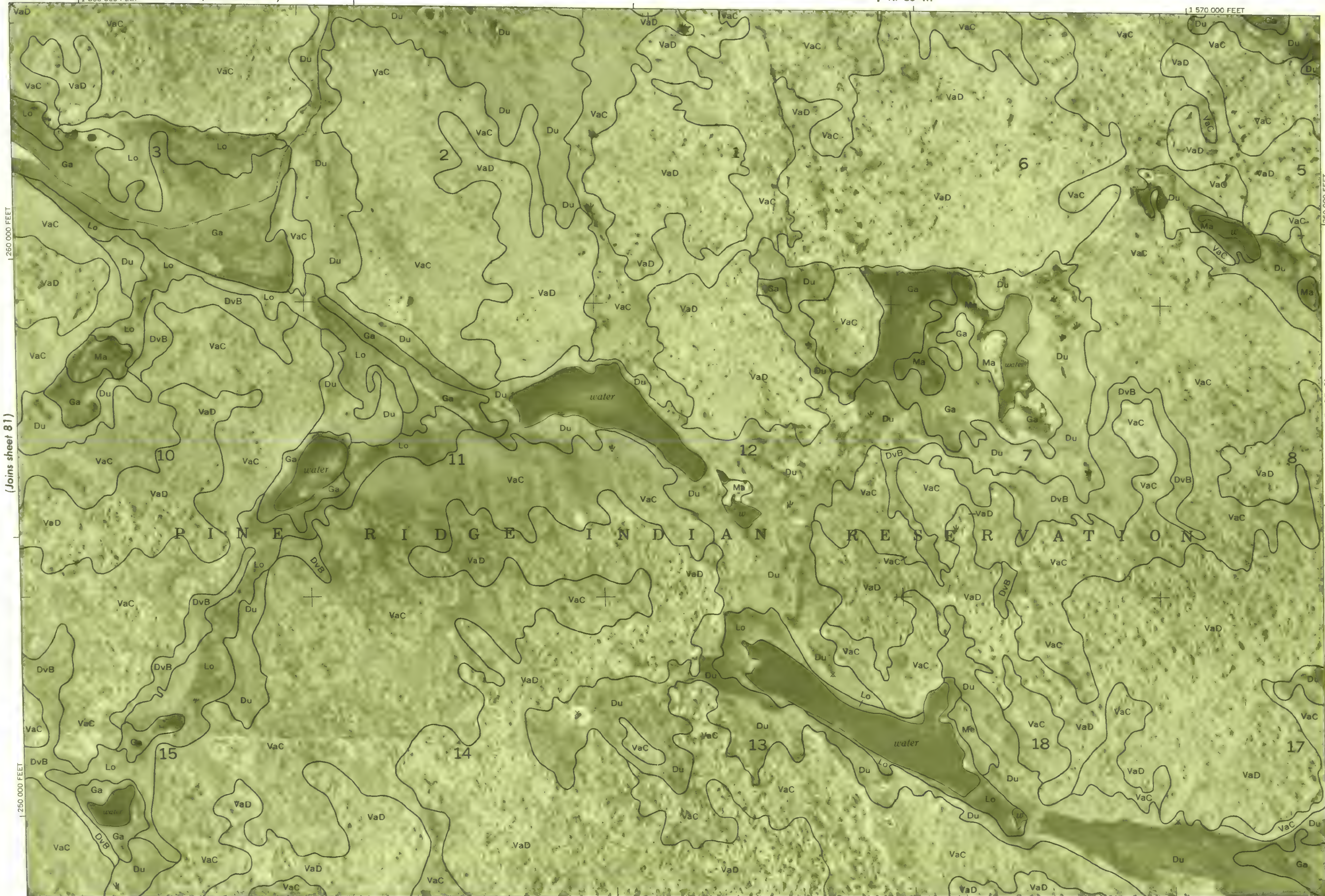
Plane coordinate projection. 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

(82)

N

(Joins sheet 72)

R. 40 W. | R. 39 W.



(Joins sheet 91)

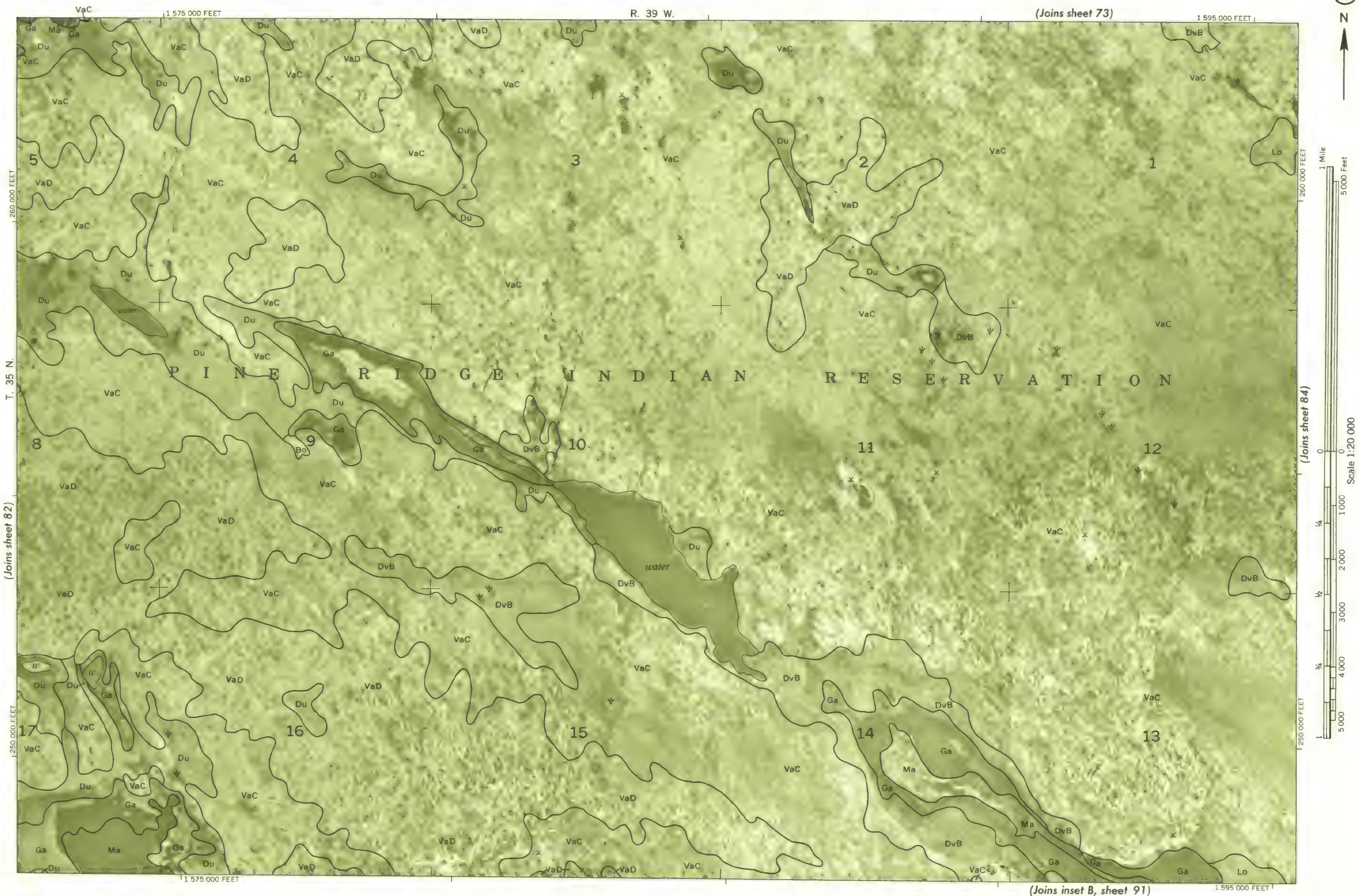
1 Mile | 5 000 Feet | Scale 1:20 000 | 0 | ¼ | ½ | ¾ | 1 | 0 | 1000 | 2000 | 3000 | 4000 | 5000

Plane coordinate projection. 1927 North American datum. 5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

BENNETT COUNTY, SOUTH DAKOTA NO. 82

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.

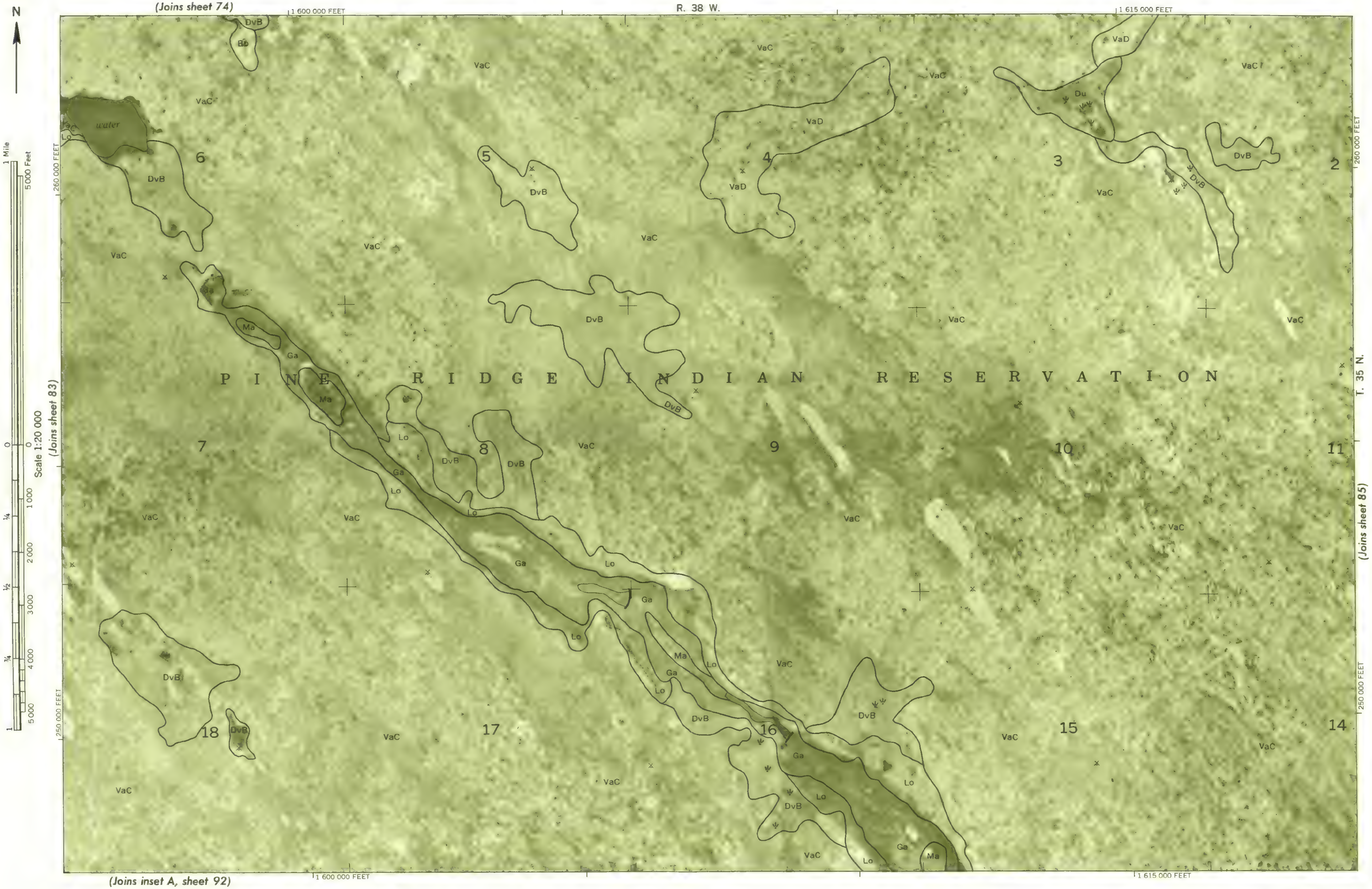


This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

Plane coordinate projection. 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

BENNETT COUNTY, SOUTH DAKOTA — SHEET NUMBER 84

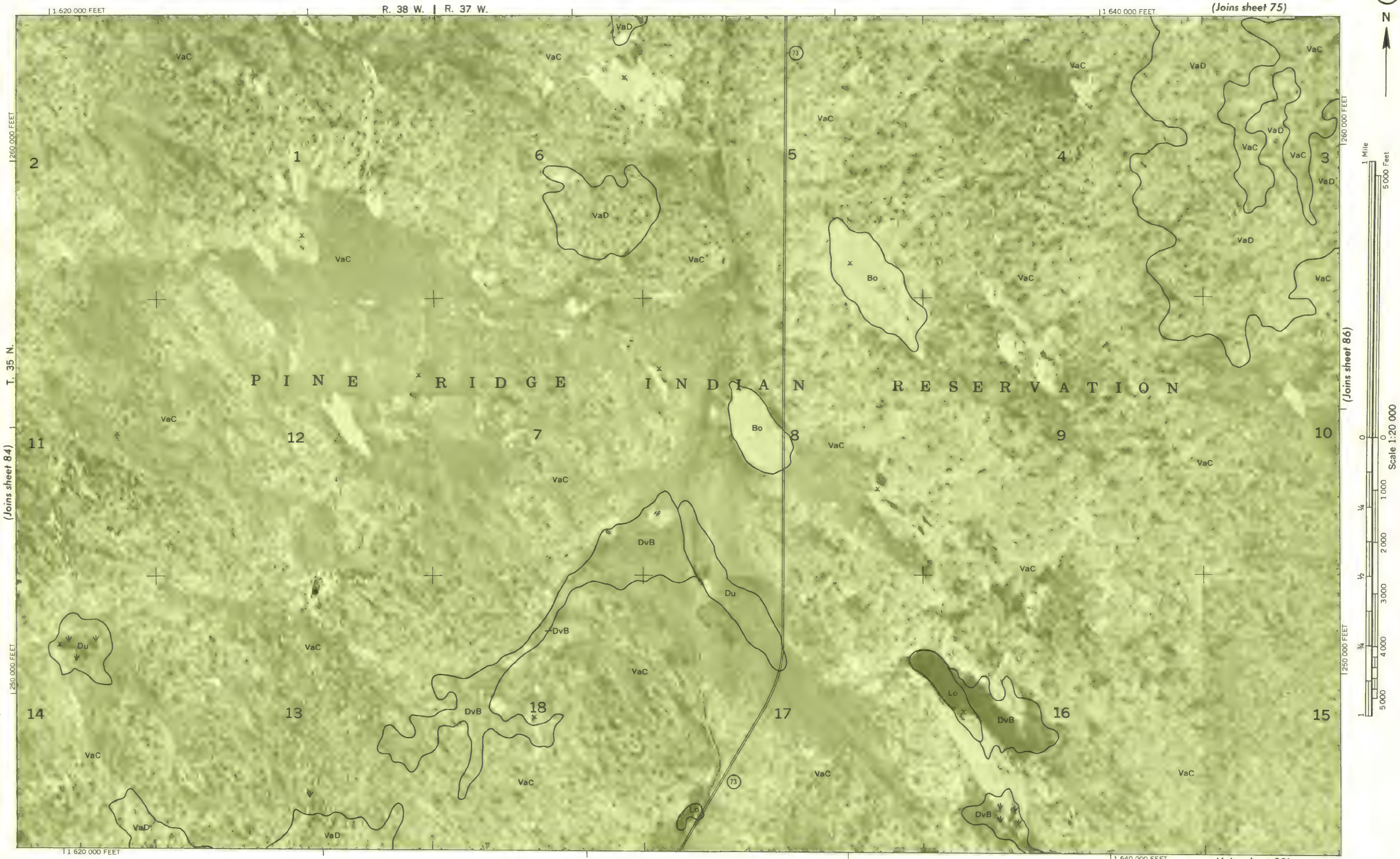


BENNETT COUNTY, SOUTH DAKOTA NO. 84

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.

Plane coordinate projection. 1927 North American datum. 5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.



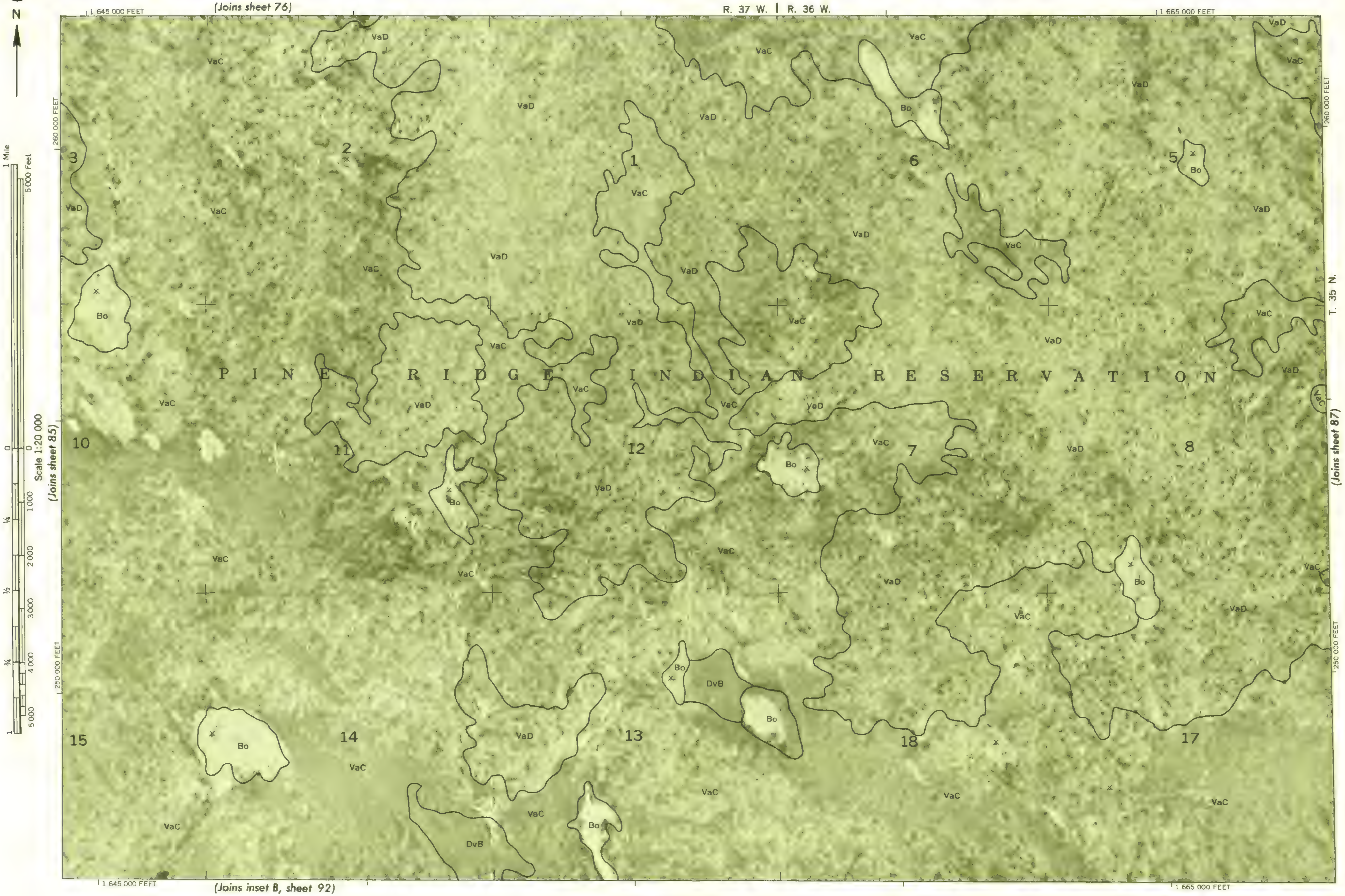
This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

BENNETT COUNTY, SOUTH DAKOTA NO. 85

Plane coordinate projection. 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

BENNETT COUNTY, SOUTH DAKOTA — SHEET NUMBER 86



BENNETT COUNTY, SOUTH DAKOTA NO. 86

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.

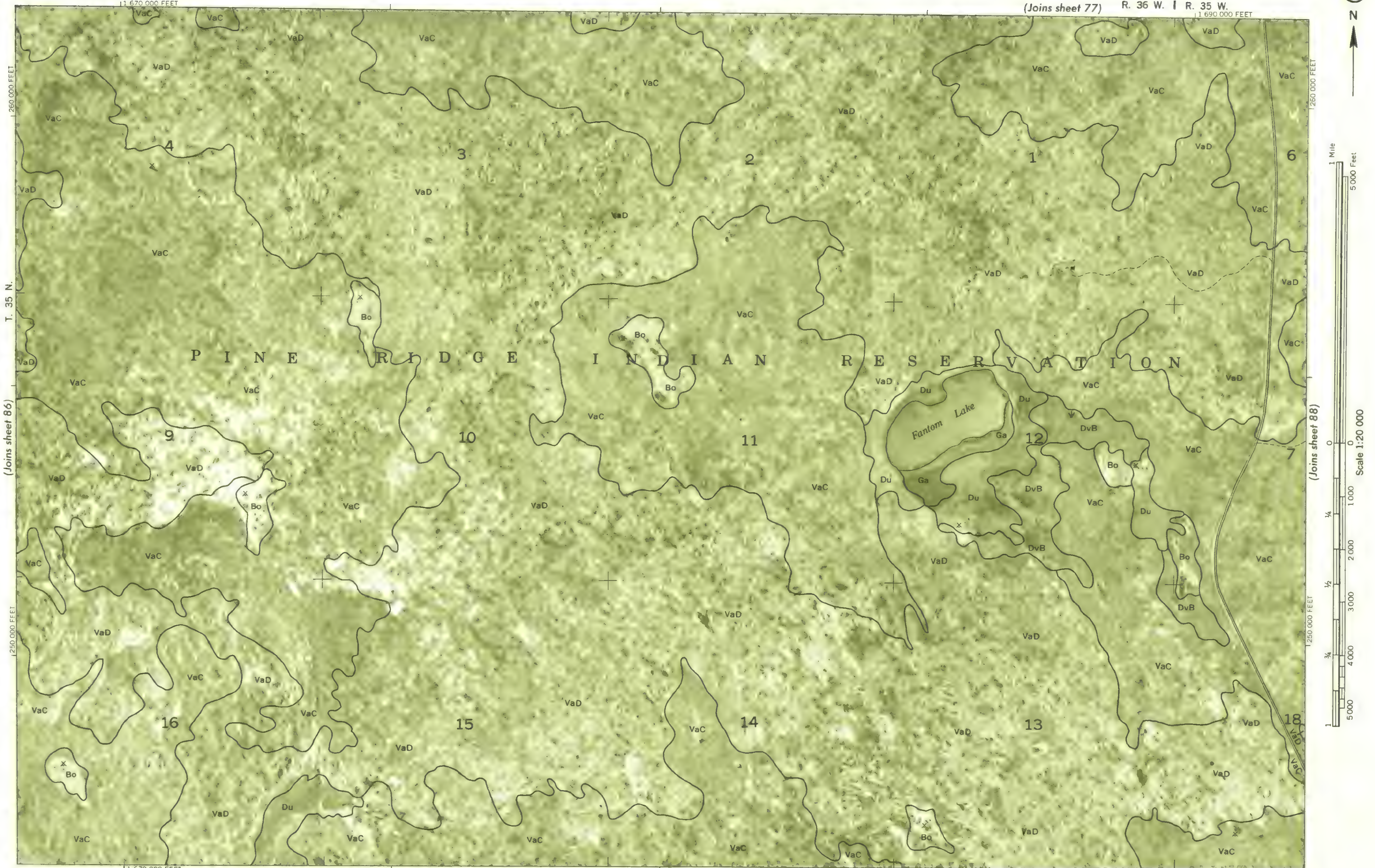
Plane coordinate projection. 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

BENNETT COUNTY, SOUTH DAKOTA NO. 87

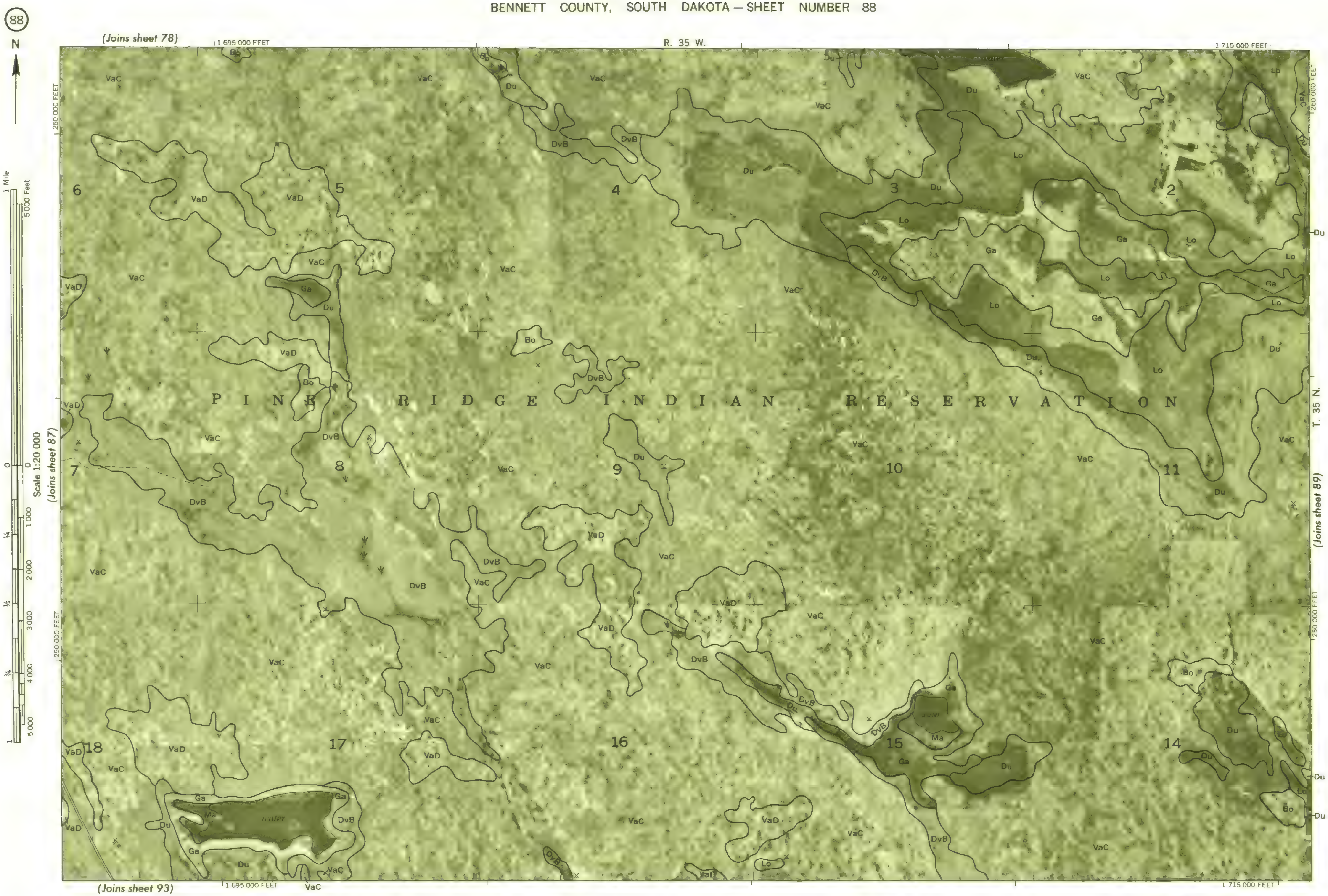
(Joins sheet 77)

R. 36 W. | R. 35 W.



(Joins inset A, sheet 93)

Plane coordinate projection. 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.



BENNETT COUNTY, SOUTH DAKOTA NO. 88

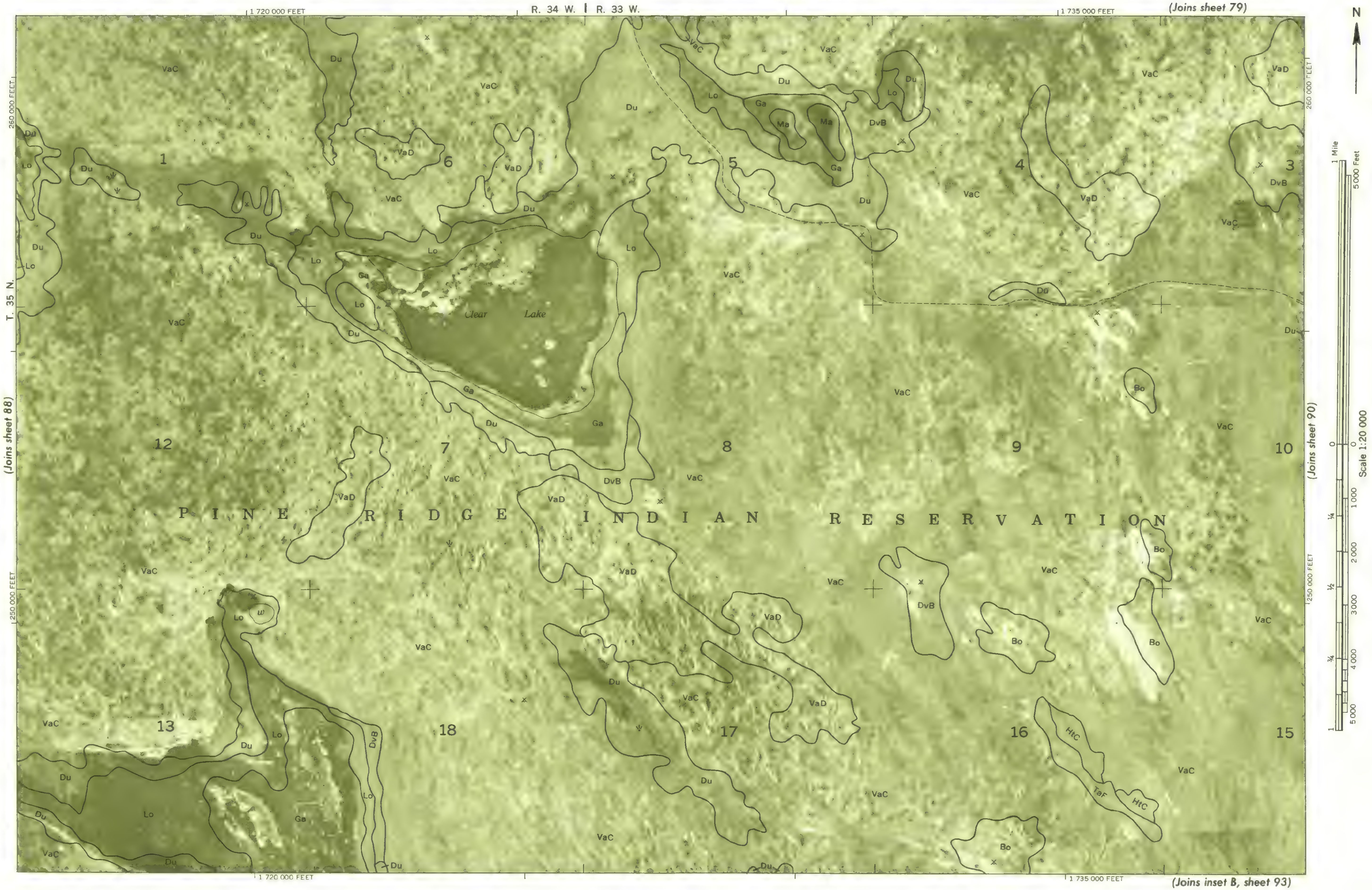
Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs and the South Dakota Agricultural Experiment Station.

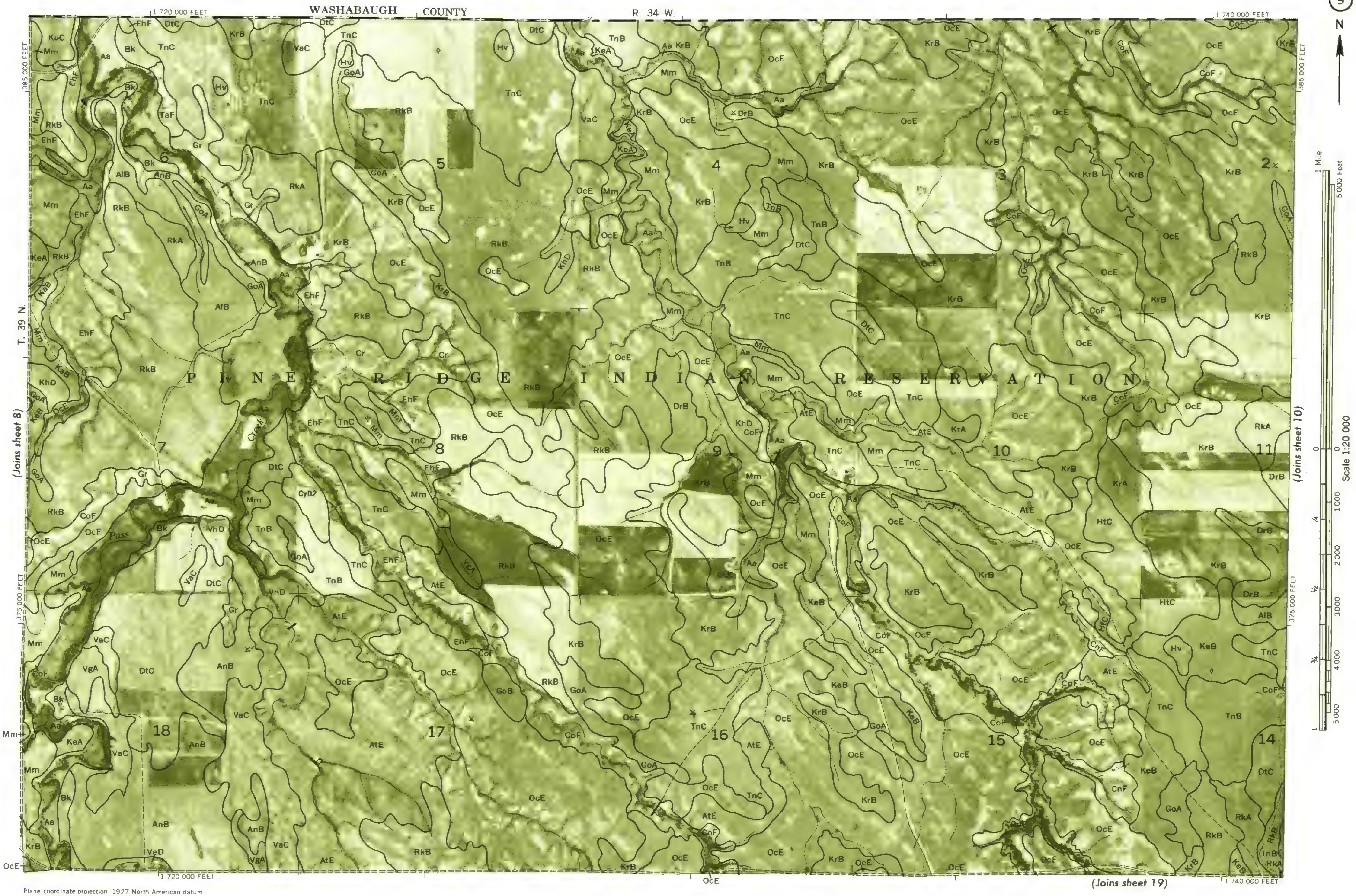
Plane coordinate projection. 1927 North American datum. 5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

BENNETT COUNTY, SOUTH DAKOTA NO. 89



Plane coordinate projection, 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.



Land division corners are approximately positioned on this map.

BENNETT COUNTY, SOUTH DAKOTA NO. 9

Plane coordinate projection 1927 North American datum
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

BENNETT COUNTY, SOUTH DAKOTA — SHEET NUMBER 90

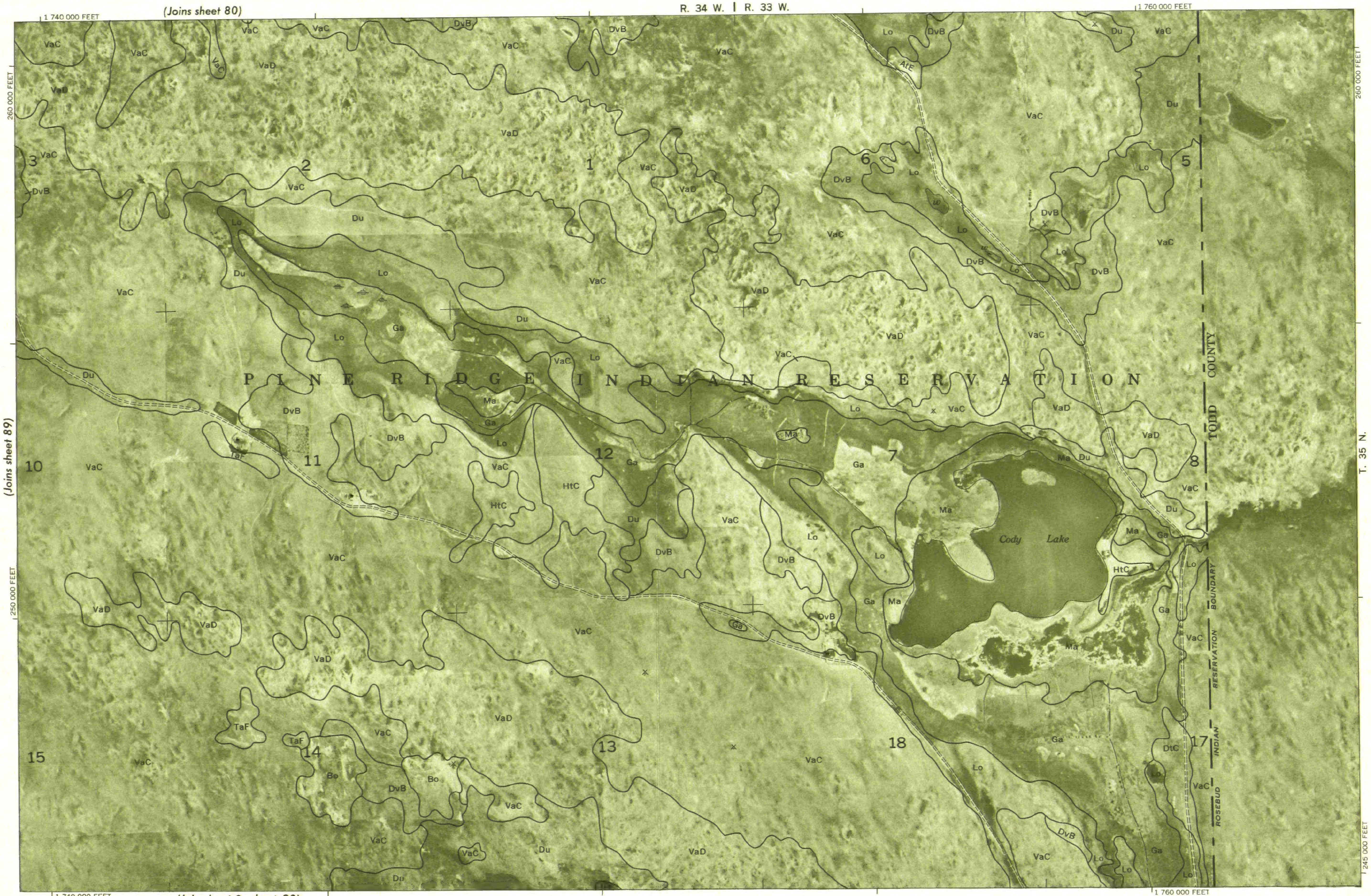
N

(Joins sheet 80)

R. 34 W. | R. 33 W.

1 740 000 FEET

1 760 000 FEET



Scale 1:20 000

1 Mile

5 000 Feet

0 1000 2000 3000 4000 5000

0 ¼ ½ ¾ 1

(Joins sheet 89)

T. 35 N.

1 740 000 FEET

(Joins inset C, sheet 93)

1 760 000 FEET

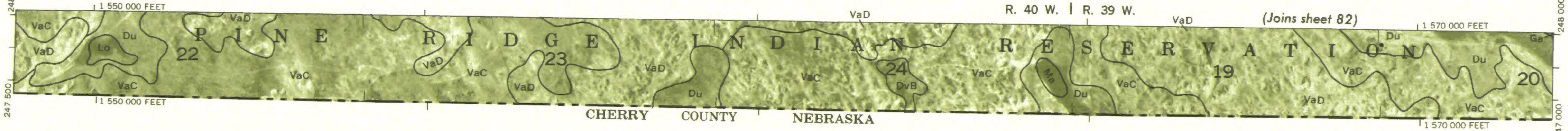
Plane coordinate projection. 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

BENNETT COUNTY, SOUTH DAKOTA NO. 90

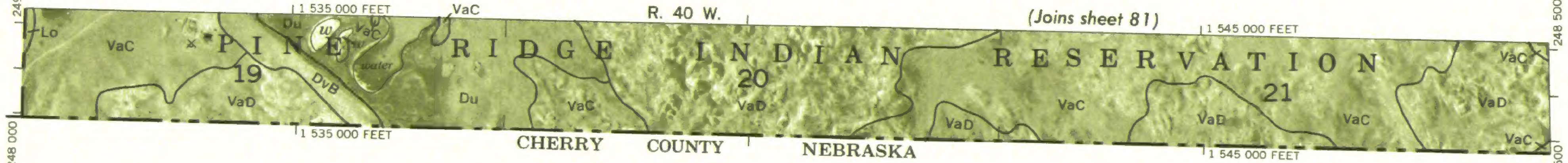
Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.

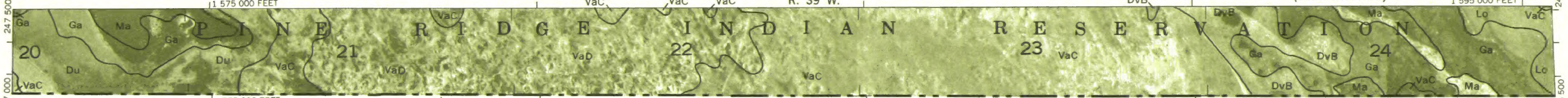
N



INSET A



INSET B



GRID TICK INTERVAL 500 FEET ON NORTH-SOUTH LINE

Scale 1:20 000

1 Mile — ¾ — ½ — ¼ — 0 — 1

5000 Feet — 4000 — 3000 — 2000 — 1000 — 0 — 5000

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.

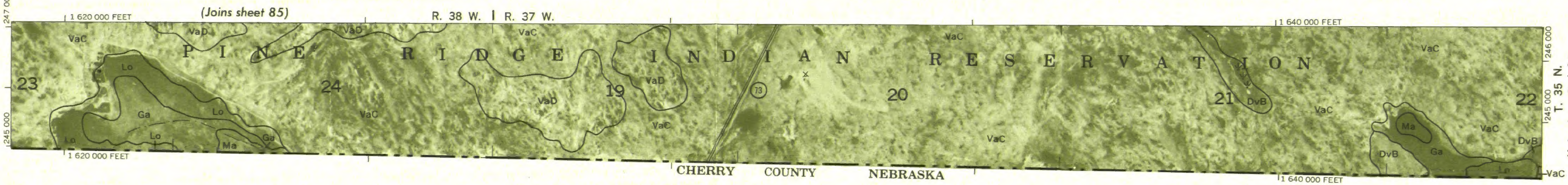
Land division corners are approximately positioned on this map.

BENNETT COUNTY, SOUTH DAKOTA NO. 91

Plane coordinate projection. 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.

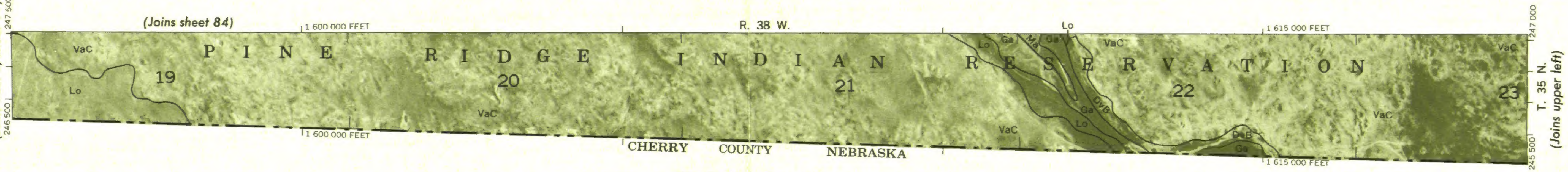
BENNETT COUNTY, SOUTH DAKOTA — SHEET NUMBER 92

N



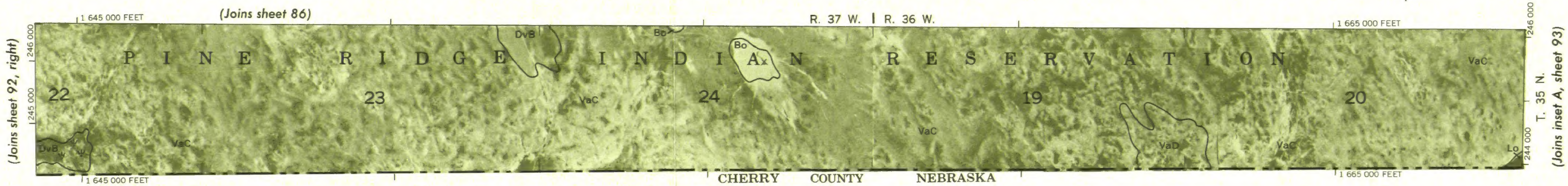
GRID TICK INTERVAL 1000 FEET ON NORTH-SOUTH LINE

INSET A



GRID TICK INTERVAL 500 FEET ON NORTH-SOUTH LINE

INSET B



GRID TICK INTERVAL 1000 FEET ON NORTH-SOUTH LINE

Scale 1:20 000

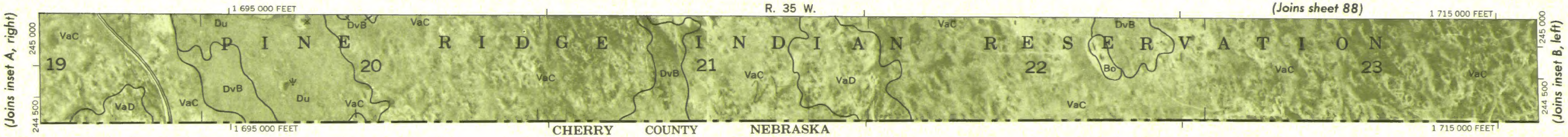
1 Mile — 5 000 Feet; 0, ¼, ½, ¾, 1; 0, 1000, 2000, 3000, 4000, 5000

BENNETT COUNTY, SOUTH DAKOTA NO. 92

Land division corners are approximately positioned on this map.

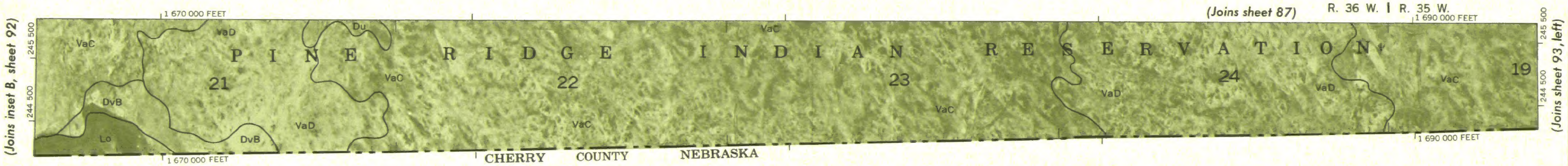
This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.

Plane coordinate projection. 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.



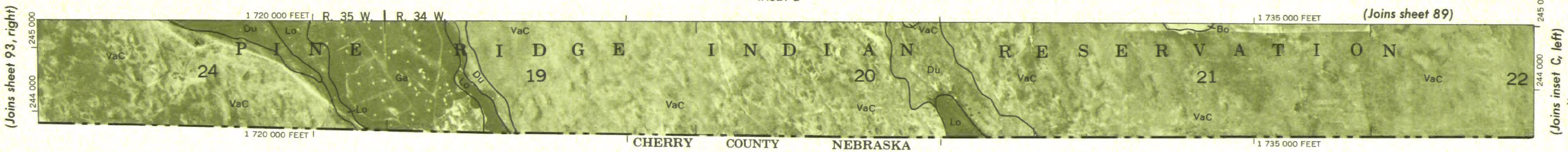
GRID TICK INTERVAL 500 FEET ON NORTH-SOUTH LINE

INSET A



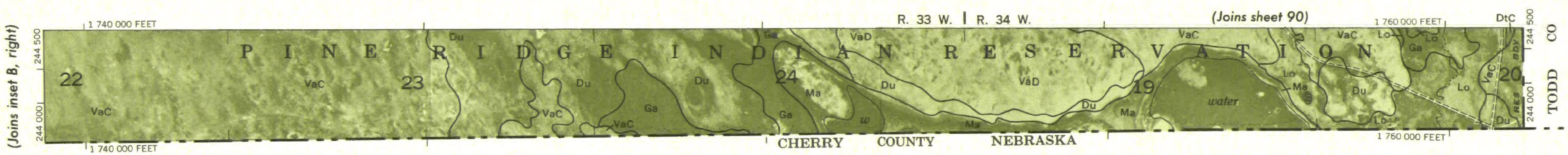
GRID TICK INTERVAL 1000 FEET ON NORTH-SOUTH LINE

INSET B



GRID TICK INTERVAL 1000 FEET ON NORTH-SOUTH LINE

INSET C



GRID TICK INTERVAL 500 FEET ON NORTH-SOUTH LINE

N

1 Mile
5000 Feet
Scale 1:20 000

This map is one of a set compiled in 1969 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

BENNETT COUNTY, SOUTH DAKOTA NO. 93

Plane coordinate projection. 1927 North American datum.
5,000-foot grid ticks based on South Dakota coordinate system, south zone. Mosaic compiled from 1961 aerial photographs.